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APRIL 1956

School Science and Mathematics

A Journal for All Science and Mathematics Teachers

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The inner side of every cloud
Is always bright and shining;
I therefore turn my clouds about
And always wear them inside out
To show the silver lining.—JAMES WHITCOMB RILEY.

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SCHOOL SCIENCE AND MATHEMATICS

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UNIT ON TREES

LOUISE RITSEMA
Haisley School, Ann Arbor, Mich.

The unit was started in the fall with a group of sixth graders at Angell School in Ann Arbor. This unit was outstanding in that it did much both for the individuals involved and the school. We were requested by our principal to label the trees on our school yard. As the unit progressed, we soon were not only identifying and labeling the trees, but were making a book for the school and individual books which included the concepts we were learning. Even guided tours for each class group in our school were conducted.

In presenting the unit to the students, our principal's request was explained to them and immediately many ideas for related activities were suggested. As the work progressed other ideas developed at each planning session and the unit grew considerably in scope.

If the trees were to be labeled we first had to determine what they were and then signs had to be made. The first aspect required research, and the second, decisions and manual labor. We finally ended up with 15 wood-burned varnished signs placed securely in conspicuous positions near each tree. White spruce and balsam were the evergreen trees identified, and mulberry, Norway maple, basswood, American elm, box-elder, witch-hazel, honey locust, and catalpa were some of the deciduous trees studied.

As each tree was identified, we decided to make some type of a leaf print of each leaf—spatter prints and printer's ink prints were made. Each child made a print for his book and then we made one choice print of each for our school book.

We learned the difference between simple and compound leaves, the types of leaf margins, and what the leaf does for the tree. Then

we talked about the shape of each kind of tree studied and with the help of the art teacher did pencil sketches of each type. This was followed by a water color painting activity in which each child using his sketch painted one tree trying to show the characteristic shape. Planning for this was carefully done so we would have one of each kind of tree for our school book.

Articles about each tree were written by committees and these were typed and run off on the mimeograph so each child would have a copy for his book and we would have one for our school book.

Much planning went into the cover and the title page for each book. We finally decided to make a hinged wooden cover on which a carefully planned title and design were wood-burned. Then these were shellacked, varnished and tied with leather. The title page was done in water color or spatter printed. A table of contents was prepared, and an introduction was written; a few of the children wrote poems about trees, and one of these was included, also.

Arranging for the guided tours for each class group was a major undertaking for sixth graders. First, careful plans had to be made for the presentations. Next, children were selected to be responsible for particular trees and then the guides were chosen. Much work was done on the individual talks and the role of the guides. During this phase of the work, one of the boys volunteered to make a map showing the location of the trees and a suggested route so that each guide

could have a copy and we could add them to our books. Discussion also took place on how each person should act during the tours.

The next major job was to schedule and invite the various class groups. A carefully planned schedule was worked out and invitations were written. Acceptances were sent us by the other classes. These trips proved very successful as now the other children understood what we were trying to do and did not disturb our signs.

The formal presentation of our book, *Trees Around School*, at an assembly, was still another highlight of our unit. Then the evening we had an open house for parents, and our booth displaying the processes involved in the preparation of our books, also proved to be another outstanding event.

At another time, we presented a short quiz about trees on the radio. But this time, just a few of the group had an active part. Throughout the year we were able to continue observation of the trees as seasonal changes took place.

In carrying out this unit, the timing of the various activities was extremely important. It was necessary for us to complete the leaf printing and the guided tours before the leaves were gone and as we worked together this was considered carefully. In order to get everything completed, many of the youngsters started work as soon as they arrived at school and others remained for short periods of time after school. Jobs would be set up for the day and then each person would follow through when his turn came—this was particularly true of the

leaf printing. Careful organization was necessary so that proper materials were available at the time they were needed.

Correlated with our science activity for this period of time were our language arts and art work. We were also able to do some incidental teaching in arithmetic.

In summary, among the values that were derived from this unit were:

(1) The children learned organization techniques and planning skills and this ability to plan and organize carried over into other areas of work.

(2) There was a feeling on the part of the group that they had done something that was of service to the school.

(3) The children recognized that each tree varies in many respects—bark, fruit, shape, leaf—and an understanding of the seasonal variation of different trees.

(4) Last but not least—the unit served as a unifying factor for a group of children who were from different rooms and not used to working together.

Refrigerator Door has an inside door release as a solution to getting trapped children free. Incorporated in the manufacturer's new line of refrigerators, the safety door release glows in the dark. All a child has to do is push the circular button to get out.

IMPROVEMENT OF BIOLOGY TEACHING*

RICHARD L. WEAVER
Conservation Department, School of Natural Resources
University of Michigan, Ann Arbor, Mich.

Two ten-day conferences have been held in 1954 and 1955 on the general problem of "How to Improve Biology Teaching in High School and College." Both were sponsored by the National Association of Biology Teachers on grants from the National Science Foundation.

The first one called the Southeastern Conference on Biology Teaching was held August 28 to September 6, 1954 at the University of Florida at Gainesville, Florida. Ninety-four participants attended from the ten southeastern states, with some staff members recruited from NABT officers outside the region.

The second conference called the North Central Conference on Biology Teaching was held August 19–31, 1955 at the University of Michigan Biological Station at Cheboygan, Michigan. Eighty-six participants attended from ten of the north central states, with some of the staff also recruited from outside the region.

In both conferences, the participants were selected to form state teams with several high school teachers, several college biologists, several teacher trainers and a public school administrator and/or a member of the state department of education.

Four objectives were selected for the two conferences. Objective number one dealt with the proper role of certain content areas in biology. At Florida the areas considered were morphology, taxonomy, physiology, evolution and paleontology, genetics, ecology and conservation. At Michigan the content objective centered on the contributions of biology to living and the following areas were selected: food supply of man, plants and man, conservation of natural resources, human inheritance, and health and disease.

The second objective was: To analyze and select some of the most important problems of biology teaching at various levels of instruction and in State Departments of Public Instruction.

The third objective was: To develop a set of recommendations for the solution of the selected problems.

The fourth objective was: to formulate plans by state teams for implementing the recommendations.

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* Read before the Biology Section of the Central Association of Science and Mathematics Teachers, November 25, 1955, at Detroit.

Organization of the Conference

Part I of the conferences was organized around discussions on the content areas.

Each of the scientists who served as consultants for each conference was asked to prepare a working paper in the area he represented, to include the following:

1. The essential subject matter necessary for the preparation of the high school teacher,
2. The most recent scientific developments of significance to that area, and
3. The experiences and methods by which such content might be transmitted to students.

The particpants were placed in five groups with as great a distribution geographically and professionally as possible.

The consultant and his recorder met with each of the small groups for two hours to discuss the content of the paper and for two more hours to discuss ways of teaching the material to teachers or to high school students.

Part II of the conferences was organized around problems of teaching biology in high school and college and problems related to certification and state department leadership.

These problems were selected by the participants, and considered in small groups. Specific recommendations on each problem were prepared by each of four groups at each of the conferences.

At general sessions the groups reported their recommendations and agreement was reached as to which recommendations were to be accepted as conference recommendations.

Part III of the two conferences was set aside for state teams to make their plans for implementation of the recommendations in their own states.

Conference Leadership

At the Florida Conference the staff consisted of Dr. Samuel Meyer of Florida State University and Dr. Richard L. Weaver of the University of Michigan as Co-Directors, Dr. Ned Bingham of the University of Florida, Dr. Hugh Stickler of Florida State University and Dr. George Jeffers of Longwood College in Virginia.

The science consultants were Dr. Herbert P. Riley, University of Kentucky; Dr. Loren C. Petry of Cornell University; Dr. C. S. Chadwick of Peabody College for Teachers; Dr. Fred R. Cagle of Tulane University; Dr. F. R. Hunter of Florida State University and Dr. Royal E. Shanks of the University of Tennessee. Numerous educational consultants from universities and state departments of education assisted in Part II of the conference.

At the Michigan Conference the staff consisted of Dr. Richard L. Weaver, University of Michigan as Director, Dr. Richard Armacost of Purdue University, Paul Klinge of Howe High School, Indianapolis, Dr. John Breukelman of Kansas State Teachers College, and Dr. Alfred Stockard of the University of Michigan Biological Station.

The Michigan science consultants were Dean Emeritus Samuel T. Dana and Professor Robert Bowman of the University of Michigan, Professor Harry Fuller, University of Illinois, Professor Harold O. Goodman, Michigan State University and Professor John S. Karling of Purdue University.

Special educational consultants were Dr. Robert Koopman of the Michigan Department of Public Instruction and Dr. Dorothy McCuskey of Bowling Green State University in Ohio.

The Report of the Florida conference was published as the January 1955 issue of the *American Biology Teacher*. Some copies are still available from Paul Webster, Secretary-Treasurer of NABT, at Bryan City Schools, Bryan, Ohio.

The complete Report of the Michigan Conference has been published as the January 1956 issue of the same Journal and also can be ordered from Paul Webster.

A brief summary of the over-all recommendations of the two conferences follows:

Florida

Many of the problems discussed by persons attending the Florida conference were related to the acute shortage of qualified high school biology teachers. The United States Office of Education has recently issued the statement that less than 60% of the high school biology teachers have the equivalent of a college major in that field. As high school enrollments increase, this shortage is becoming more acute. At the same time, an increasing number of high schools are requiring all students to have courses in biology and a decreasing number of college graduates are choosing high school biology teaching as a profession.

The Conference approached this problem from two standpoints: to improve the quality of training for the high school biology teacher and to make his job more attractive after he has gotten into it.

To improve training the Conference recommended that the prospective high school biology teachers have a college major in biology which will include one year of General Biology or courses in General Botany and General Zoology. At least one-third of this training should be in plant science. The Conference recognized the need for field studies in the teacher's advanced training. To provide a broad

training that will make modern biology meaningful and, at the same time, qualify the teacher to instruct in related scientific fields, it was recommended that he have a year each of chemistry and physics, with laboratory work, a year of mathematics and some training in earth science. It was further recommended that he take the necessary education courses to fulfill his state's certification requirements. A course in the methods of teaching high school biology was considered essential. It was agreed that the high school biology teacher should have the same broad training in the humanities, social studies and communication skills as teachers in other areas. The Conference regarded these recommendations as the minimum training needed by the high school biology teacher to prepare him for his work.

The Conference recognized the need for helpful consultant services to be provided the high school teacher. It was felt that the needed advice was too often lost in other assignments. For that reason, the Conference recommended that the various states take the necessary steps to concentrate their consultant services in the hands of a single individual who would have no other major responsibilities.

In order to meet the demands for increased numbers of high school biology teachers, the Conference recommended that his position be made more attractive by the establishment of salary and pension schedules more nearly comparable to those of other professional groups in industry and government which require comparable training, by encouraging promising high school students to choose biology teaching as a profession and by issuing temporary certificates to persons who do not meet the minimum requirements provided they continue their professional training toward meeting such requirements.

The Conference recognized that the high school student is to be trained to take his part in community life and that his work in biology should make a definite contribution to that goal.

Michigan

Some of the recommendations from the Michigan Conference are: (1) Colleges should continue and increase their efforts to help recruit, train, and assist high school teachers of biology; (2) College and professional groups should continue and increase their efforts to hold refresher-type conferences, institutes, and classes to help teachers in service to keep up with new developments in science; (3) College administrators should arrange for cooperative planning between science departments and the educational departments or schools to assure adequate training in science as well as in education; (4) Colleges should arrange to have beginning courses taught by those

scientists who are richest in experience, most enthusiastic about their subject, most effective in exposition, and most interested in students; (5) Colleges should provide seminars for college teachers on educational philosophies, teaching methods, and the problems confronted by college teachers; (6) Colleges should develop curricula for high school teachers which will meet their specific needs; (7) College scientists should continue and increase their efforts to help high school teachers and students so as to stimulate the more gifted students into electing science as a career; (8) High Schools should plan their biology programs so as to better meet the individual needs of all students, and especially the gifted ones, and should make a greater and more effective use of better teaching methods, texts, and audio-visual materials through community study, group work, and use of outdoor laboratories, school camps, forests, and gardens. (9) High school teachers should keep themselves up to date through use of professional organizations, advanced study, and cooperative planning with other subject matter groups, and (10) State departments of education should use scientists and science teachers more generally in helping to establish certification requirements for teachers.

A more detailed summary of some of the recommendations aimed at improvement of high school biology teaching includes the following:

Meeting Student Needs in High School:

In order to insure adequate recruitment and education of future scientists, sound and stimulating science teaching is needed from elementary grades through high school. It sould include a biology course which meets the individual needs of all pupils. Capable students interested in science should have an opportunity to become acquainted with working scientists. Teachers should make it possible for all students to work at their maximum ability through a flexible program in which students help to determine and to achieve many of their own objectives and all of the valuable scientific resources of the school and community are utilized.

Using Scientific Methods in Teaching:

One of the primary objectives of the high school course in biology is to develop scientific attitudes in students. The teacher must be informed on the problem of the nature and meaning of science and the methods of science. A distinction needs to be made between the creation of science through research, and the application or use of science. Teachers must use the methods, approaches, and attitudes

of scientists. They should use some of the classics of science and show how the scientists attacked their problems. Students should have the opportunity for experiences in using scientific methods in securing answers for themselves.

Interrelationships between Biology and Other Areas and Levels of the School Curriculum:

Some relief from an over-crowded and ever-expanding biology course can be achieved through better and more continuous science teaching in the elementary and junior high grades. Cooperative planning between teachers, administrators, and students can strengthen the science programs in the direction of better preparing all students for living and for further work in science. Students need opportunities to apply in other classes what they have learned in biology, and biology should help other teachers achieve some of their objectives too.

Effect of Scientific Developments and Social Trends on Biology Courses:

Biology cannot remain static. The use of modern drugs, the increasing need for conservation, and the judicious use of land and water to feed millions more people, the whole field of biophysics, requires an ever changing biology course. Teachers have, and need to use, the many opportunities for keeping up-to-date through their professional journals, refresher courses and institutes at colleges, and in-service study programs. More intensive science courses can be achieved too, if greater emphasis is placed on strengthening the mathematics courses in high school.

Improving Methods of Instruction:

Experience has demonstrated the necessity for the use of many methods and techniques in the teaching of biology. The teacher should be familiar with many methods in order to select wisely the proper methods to fit best the situation. Better use of texts, references, and audio-visual materials, more adequate appraisal and wider use of community resources, particularly out-door laboratories, study areas, school camping, school forests, gardens and the like.

A multi-text system or classroom library is generally preferable to the use of a single text. This discourages the use of the text as the prescribed course of study; encourages comparison, may aid in critical thinking and may encourage a greater variety in the types of teaching activities. School budgets should include provision for purchase of desirable materials and apparatus necessary for good teaching procedure.

Administrators Can Help to Improve Biology Teaching:

By obtaining the best cooperative thinking of all groups, including the science teachers, some laymen and scientists, many of the most pressing problems related to class size, adequate laboratory and library facilities, adequate financial support, and teaching load, much progress can and needs to be made. Alert and progressive administrators are doing this continuously now, and should help each other in a united effort of school improvement.

Better planning of science rooms with more flexibility should result in a richer program with more contact with live and prepared materials, more experiments, more use of audio-visual aids, and references. Science teachers should be provided with a preparation period, and their load should be determined by the number of contact hours with students, plus preparation needs.

For the detailed recommendations concerning biology teaching in college, and ways state departments and other administrative units can help to improve biology teaching, it is suggested that you secure a copy of the January 1956 issue of *The American Biology Teacher* for a complete report.

PROFESSOR SATHER, CONSERVATION EDITOR

Dr. J. Henry Sather received his B.Sc. degree from the University of Nebraska in 1943, M.A. degree from the University of Missouri in 1948, and Ph.D. from the University of Nebraska in 1953.

During the years 1948 to 1955, Dr. Sather was associated with the State of Nebraska Game, Forestation & Parks Commission. From 1948 to 1954, he was in charge of the fur investigational phases of the Nebraska Pittman-Robertson program. In this capacity, he conducted an intensive study of the life history and ecology of the Great Plains muskrat. In 1954, Dr. Sather was placed in charge of Nebraska's Pittman-Robertson Investigational Projects. In this capacity he planned and administered upland game, waterfowl, and furbearer research studies.

In September, 1955, Dr. Sather accepted a position on the staff of the Department of Biological Sciences of Western Illinois State College at Macomb, Illinois. His decision to enter the teaching profession can largely be attributed to his conviction that the greatest need in the conservation field today is a sound conservation education program.

SECOND THOUGHTS ON ECONOMY IN ORDERING LABORATORY SUPPLIES

E. S. RUSSELL
Cambosco Scientific Company, Boston, Mass.

As one means of stretching the science-budget dollar, it has been suggested* that the annual order for supplies and equipment be divided among four or more supply houses.

The anticipated advantage of that procedure is documented by four tabulations of prices copied from "catalogs of various companies." One source is described as "a general purpose supply company"; another as a "general laboratory equipment company." Although the difference between them is not clear, those designations permit the inference that prices were taken from catalogs of the encyclopedic type, which are published at intervals of four to seven years.

As can be testified by any catalog compiler, hundreds of prices may be obsolete by the time the *latest* edition of his work is printed and bound! When one compares the price charged today by Company "X" with that shown by Company "Y" in a catalog issued a couple of years ago, the differential should not be construed as an achieveable economy. In the interim, the gap may well have been closed by successive advances in wages, and in the cost of raw materials.

Just for the sake of argument, however, it is interesting to assume that all of the prices in the cited tabulations were simultaneously in effect. How, then, could Company "C" furnish at $5.40 the St. Louis Motor for which Company "A" charged $8.35?

In the most recent report to its stockholders, a large laboratory supply house reveals a gross margin equal to 30.2% of total sales; a net profit (after operating expenses and taxes) amounting to 2.25%. In other words (and in round figures) seventy cents of the sales dollar were spent for merchandise; twenty-eight cents were required for operation of the business; two cents were left to compensate stockholders for the use of their money, and to provide for unforeseen contingencies.

Let us return to our motors—to the St. Louis Motors for which Company "A" asks 55% more than Company "C." It is seen that the difference is nearly double the *gross* margin which a typical supply house reported to its expectant stockholders. Since manufacturing costs are known to be substantially uniform throughout the industry, the foregoing percentages may be taken as presumptive evidence of disparity in quality—despite the contrary assumption made by the author of the original study.

* Kwast, Virgil. "Economy in Ordering Science Supplies," SCHOOL SCIENCE AND MATHEMATICS, LVI, No. 1, Jan. 1956.

If that conclusion is sound, it may prove that the A.C. Voltmeters, offered at $8.33 and at $19.50, are not equivalent in respect of sensitivity or accuracy. At once, let it be added that the more expensive meter may, or may not, represent the better value.

Fortunately for the science teaching profession, there are in the United States many dependable sources for laboratory supplies. Some of them thoroughly justify the sales argument: "Costs a little more, but well worth the difference." Others successfully substantiate the claim: "Saves money, without sacrifice of utility." Proponents of the latter philosophy do not, however, represent their products as being identical with the more elegant or more elaborate counterparts. For the buyer to make such an assumption is to invite disappointment.

Strangely, the "sample order of supplies that might be needed by a small high school" includes none of the materials known to the apparatus industry as "franchise items." For such materials, consumer prices and discounts are established, not by the laboratory supply house, but by the manufacturer, who requires price maintenance by all who handle his wares.

Included in the broad category of franchise, or fixed price, items are: weighing equipment, high resistance glassware, laboratory porcelain, graduated glass articles, chemicals of reagent grade, compound microscopes, projection apparatus and other optical instruments. The cost of such products clearly can not be reduced by ordering them from a plurality of vendors.

The thesis that: "more equipment may be purchased on the same budget if laboratory supply orders are split up" would seem to disregard the not inconsiderable factor of transportation cost. Whenever merchandise is moved by a common carrier, the transportation charge varies not only with weight and distance, but also in accordance with the kind of materials and the method of packing. When the charge for one large shipment is compared with the cost for several small consignments, the whole is found to be less than the sum of its parts.

In the examples before us, chemicals would have been ordered from Company "D," at $24.32, because the prices used by Company "A" add to $27.64. But the schedule of reagents includes Carbon Bisulfide which, under I.C.C. regulations, can be shipped only by freight. The small order for Company "D" will therefore be assessed the minimum freight charge—at the rate applicable to a hundred-pound shipment. If the goods travel one hundred miles or more, the "saving" of $3.32 turns out to be a loss. Had the entire order been sent to Company "A," the chemicals would have represented an insignificant fraction of the total transportation cost.

Objective analysis of the data used by the previous writer augurs

ill for fulfillment of his hope that: "If . . . a larger group of suppliers were considered, there might be a wider difference in the cost of materials."

What, contrariwise, can be expected by the science instructor who entrusts his annual order to one supply house—to any supply house in whose integrity he has confidence? Minor advantages are that he has one order to prepare, one packing list to check, one invoice to process and a single, reasonable transportation charge to pay. More important is the fact that, upon the source of his choice, he places undivided responsibility for timely delivery of satisfactory equipment. In precisely that way, many thousands of science teachers find it logical, and economical, to place their annual orders for apparatus, reagents, specimens and sundry supplies.

A PROGRAM FOR HIGH SCHOOL SCIENCE AND MATHEMATICS TEACHERS

Fifty high school science and mathematics teachers chiefly from Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio and Wisconsin will attend the University of Wisconsin during the 1956–57 school year, supported by a grant from the National Science Foundation. Each teacher will receive a stipend of $3,000 with an additional allowance of $300 for each dependent, plus tuition fees and some travel allowance.

Each teacher will pursue a program of study planned specifically for him (or her) designed to increase his effectiveness as a teacher. Such programs will be selected from (a) refresher courses in the fundamentals of biology, chemistry, mathematics and physics, (b) a seminar in the teaching of science and mathematics, (c) selections from the university's regularly offered graduate courses in science and mathematics, and (d) a regular university course, Contemporary Trends, devoted to the impact of science on society. Credit earned by the teacher may apply toward a Masters Degree in science education or in one of the subject-matter areas, biology, chemistry, mathematics or physics. Some adequately qualified teachers may earn the Masters degree during the 9-month academic year; others will require longer.

To be eligible for selection a teacher must: (1) Have a Bachelor's degree. (2) Have taught in high school for at least 3 years and must presently be employed as a high school teacher of science or/and mathematics. (3) Have adequate scholastic ability as indicated by the college or university transcript. (4) Have high potential ability as a teacher and high character, as evidenced by letters of recommendation. (5) Be under 46 years of age.

Any high school teacher who can satisfy these basic requirements is eligible to apply for a grant.

The University of Wisconsin is one of two schools selected for the 1956–1957 experimental program, the other being the Oklahoma Agricultural and Mechanical College; the latter will draw its teachers largely from the south central area states. If the results of the 1956–57 program are sufficiently promising a total of 8 colleges and universities covering all areas of the United States will conduct similar programs in 1957–58.

Mercury Sweeper for laboratories makes a simple operation of retrieving spilled mercury. The use of an amalgamated wire roller "magnet" gathers the mercury into a single pool from any surface.

THE ELECTRIC DOUBLER: AN ELECTRIC PUMP

J. O. Perrine
36 Marion Road, Upper Montclair, N. J.

The simple phenomena of electrostatics have intrigued man's imagination for thousands of years. The interesting and surprising attraction and subsequent repulsion of amber for small bits of paper and other small objects prompted the ancients to call the phenomena, electrical. The Greek word for amber (a fossilized resin) was electron.

It is ever very much in order in preparation for any and all jobs in the Signal Corps and electrical industry to begin one's study of electrical phenomena and principles with a "good look" at electrostatics.

A beginning of electrical vocabulary is acquired thereby. Basic concepts of electrical field, of electrical potential, of electrical energy, of conductors, of capacitors, of insulators, and of dielectrics are simply and logically developed in the experimentation with the electric doubler; the training aid to be described in this brochure.

It is not often true in physical science that a single piece of apparatus embodies almost an entire course of study in a branch of that physical science. However, in the case of the electric doubler shown below, one has such a single item of equipment. It makes possible a series of simple experiments which dramatically portrays almost every phenomena, principle and doctrine encountered in the study of electrostatics.

The electric doubler, as the apparatus is called, was first devised by Lord Kelvin in 1865. It makes possible an understanding, in a very basic and dramatic fashion, of an electrical field, electrical potential or voltage and field energy. It helps one to get a sense of reality of lines of electric force existent in the electrical field surrounding a charged conductor. It helps one to realize that energy is required to charge an electrical conductor and to charge a capacitor. It helps one to appreciate that an electric field and lines of electric force, associated with a capacitor, embody energy. Even though a human being can neither see, smell, taste, feel, nor hear lines of electric force, this training aid does give visual evidence that they exist and constitute an electric field.

The arguments behind the functioning of the training aid are based on perfectly valid assumptions about the properties of the electric lines of force, namely, a longitudinal force along them tending to contract them and a lateral force between them tending to separate them. These assumptions were propounded and heartily advocated by Faraday (1791–1867).

The Apparatus: The Training Aid

The sketch shown in Figure 2 and photograph (see Figure 1) of the electric doubler shows that it is a very simple arrangement. It can be thought of as an electric pump. Two metal cans *C* and *D* stand on separate boxes. These boxes are made of polystyrene plastic which is an excellent insulating material. *S* and *S'* are narrow strips of metal extending upwards from the metal cans *C* and *D*. The lines *T* and *T'* represent metallized or tinseled cotton threads at whose ends are pieces of corn stalk pith. The metalized cotton threads enable the pith balls to readily get an electric charge from the metal cans as the cans get charged in the operation of the "pump."

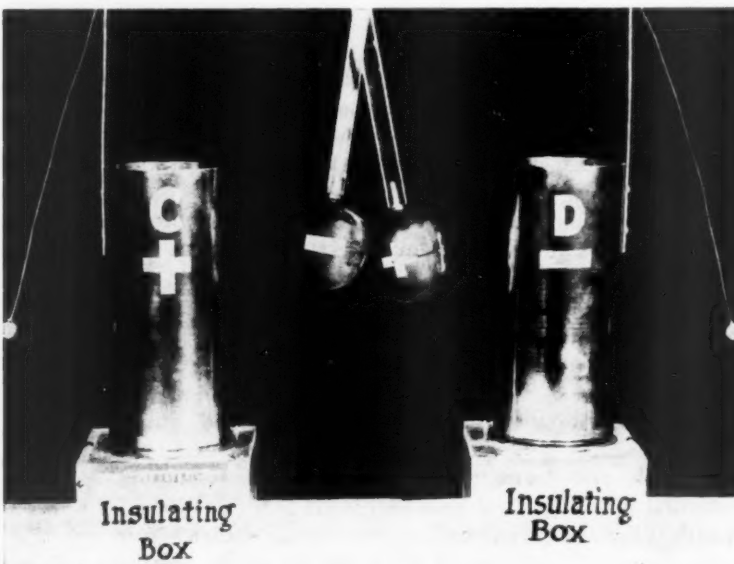

Fig. 1

The metal balls *A* and *B* are attached to insulating handles, *H* and *H'*. These handles are made of polystyrene also.

Modus Operandi: First Step: Getting Ready for the "Priming" of the Electric Pump

To start the electric doubler of the electric "pump," one must get ready for the "priming" of the pump. It is necessary to give the two metal cans a small initial electric priming charge of opposite kind.

By rubbing a glass rod with a piece of silk cloth, the glass rod will get a positive electric charge. Just for fun at this point, show that the

pith balls attached to the cans *C* and *D* will be attracted and then repelled by the positively charged glass rod.

The positively charged pith balls are to be then discharged by touching them with the hands.

Now touch and rub the charged glass rod to the metal ball *B* which has insulating handle. The metal ball *B* will get a positive electric charge.

MODUS OPERANDI: SECOND STEP: THE "PRIMING"

To prime the pump put the positively charged ball *B* down into can *C* at operator's left. The positive charge on ball *B* will now be given to can *C*. The priming process has begun.

The second part of the "getting ready for the priming" process now must be done. Proceed exactly as above with an ebonite rod and

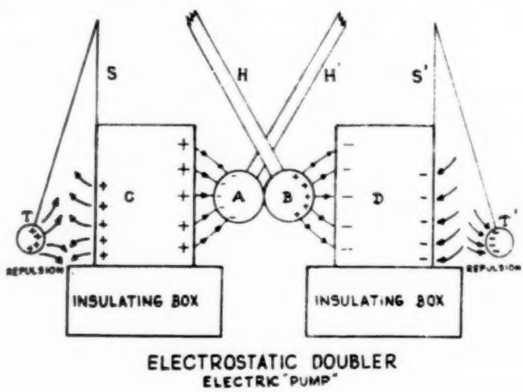

FIG. 2

a piece of woolen cloth to get a negative charge on ball *A*. To get a negative charge on ball *A*, it is necessary to touch and rub the ebonite rod on the ball.

The next step is to place the negatively charged ball *A* down into can *D* at operator's right so as to give its negative charge to can *D*. The final step in the priming process has been accomplished.

A small electric field and a small number (5) of lines of electric force now exist between the two charged cans *C* and *D*. These lines terminate, one can say, on can *C* and as such these terminations are the positive charges on the can. The terminations on can *D* comprise the negative charges.

One can now say that the electric pump has been primed and is ready to function with the "pumping" and energy provided by the operator and demonstrator of the training aid.

One could prime the pump as above described or it could be primed by touching the charged glass rod to the can *C* and the charged ebonite rod to the can *D*.

ELECTROSTATIC DRY "CELLS"

In passing, it is in order to discuss, a bit, the production of charge by sheer contact.

The glass rod and silk cloth constitute an electrostatic dry "cell." Due to a basic phenomena, afforded by nature, which is a simple but an unexplainable one, the glass rod acquires what is conventionally called a positive charge when it is brought into contact with a silk cloth. The silk cloth acquires a negative charge also in the sheer process of contact. It is oftentimes said that the electric charges in this case are produced by friction. Friction really has nothing to do with the phenomena. Rubbing merely helps to make the contact more intimate and close. The rubbing may serve to clean the surfaces a bit.

Just why positive and negative charges appear as the result of sheer contact of two different kinds of stuff, glass and silk and ebonite and woolen cloth, is difficult for man to appreciate. Both materials in both cases are dry and one has an electrostatic dry "cell." One must accept the phenomena as one of nature's bounteous gifts to man.

THE RESTLESS ELECTRON

It would not be an explanation but one might say, in searching for understanding, that the restless negative electrons in the glass have an innate wanderlust which impels them to spontaneously migrate from the glass over into the silk cloth when the contact is close. Their seemingly irrational departure causes the glass rod to be positive as to kind of charge and the silk cloth negative.

Likewise, the seemingly irrational departure of the restless negative electrons of their own free will from the woolen cloth onto the ebonite rod causes the ebonite rod to be negatively charged and the woolen cloth to be positively charged.

As viewed and judged by man, the behavior of restless electrons does not make sense. Why electrons have a roving disposition, nobody knows. The sheer fact is, however, that the two kinds of stuff do get opposite electric charges by close contact and man is provided with an electrostatic dry cell because of the existence of a basic phenomena and truth.

During the intimate contact of two different pieces of dry stuff, the voltage existent between the two charges is small. However, one luckily is provided with an initial priming charge. When the two pieces of dry stuff, which have a tiny force of electrostatic attraction between them, are pulled apart by the operator, the operator does

work or expends energy. The result is that the voltage between the two pieces of dry stuff is raised. The electric charges (positive and negative) are not increased but the voltage between them is increased by the separation process up to 10,000 volts or more.

Another good example of a real "dry cell" in the same category with glass and silk and ebonite and woolen cloth is the thermocouple.

If a junction of copper and iron for example has a different temperature than the other ends of the two metals, a voltage exists between the copper and iron at the hot junction.

Under the environment of temperature, the restless electrons of one metal spontaneously migrate into the other metal to produce a voltage. One has a thermo-electric "dry cell."

It is a different kind of "dry" cell compared to the glass and silk cloth. The voltage is a fraction of a volt but the voltage does exist because of the same doctrine as involved in the sheer contact voltage of an electrostatic "dry cell." The rational reason for such a thermo-electric voltage is not easy to comprehend on the part of man.

Another kind of "dry cell" is the photronic light cell. These are the light meters of the photographers. Due to the radiation of light on a contact of two dissimilar metals, a voltage is brought into being. It is a small voltage and it is a seemingly spontaneous voltage. In this case, the light seems to supply a stimulus which increases the restlessness of the electrons and enhances their wanderlust.

A Chemical Wet Cell

The same sort of phenomena occurs in the zinc, carbon, ammonium chloride (sal ammoniac) so called "dry" cell and in the various kinds of wet cells. The common "dry cell" is not dry. Whatever the liquid or wet paste is, the positive electrode acquires a voltage with respect to the liquid or paste by sheer contact. The negative electrode acquires a voltage with respect to the liquid or paste by sheer contact. The restless electrons do their act again in exactly similar fashion as for dry contact.

In the present case of the training aid, positive and negative charges are produced in both contacts; glass and silk cloth; ebonite and woolen cloth. Both the charge and voltage are supplied by sheer contact in the electrostatic "dry cell." The inherently and intrinsically existent voltage is raised by the separation of the two sets of two electrodes which requires an expenditure of a small bit of energy on the part of the human operator.

Voltages in this latter case may be 20,000 volts. In the "wet" cell, the voltage is 1.5. The voltages exist because of the same basic process and phenomenon happily provided by nature.

In the winter time, one may get quite a sizable spark from a door

handle when one walks across a rug or slides on a nylon auto seat cover. This spark is evidence of high voltage.

The Why of the High Voltage

The initial voltage arising from the sheer contact of the glass rod and silk cloth is small. It is a sort of "priming" voltage. When the positive charge on the rod and the negative charge on the cloth are pulled apart against the attraction force between them, the operator or demonstrator must do work, must expend energy. He does not do a large amount of physical work but the voltage is thereby raised to what seems a very high value: 20,000 volts.

The electrical energy available is very small.

In the case of the 1.5 volt primary cell, the voltage is small but due to the chemical energy available within the cell, the electrical energy is quite sizable.

Modus Operandi: Third Step; The Pumping

In a basic way, a small electric field embodying a very small amount of energy now exists in the space or in the insulating air between the two cans *C* and *D*. The voltage between the two cans is also very small. In a perfectly valid fashion, the two cans can be thought of as a capacitor with a bit of air between as the insulator and the dielectric.

It is to be remembered that lines of electric field have a tension or pull along their length tending to shorten them and a lateral or side-wise push between them tending to separate them. Like elastic springs under a mechanical tension which embody potential energy, so the suppositional lines of electric force represents a bit of potential energy due to the electrical tension along them and the lateral push between them.

The second step in the modus operandi procedure is to remove the balls from the cans and then touch the two uncharged metal balls *A* and *B* in the space between the cans as shown in photograph and sketch. The cans are to be about 5 inches apart. The handles to the balls are crossed and balls are touched to one another. The operator can readily pull ball *A*, in the right hand, over to the right and put it down into and touch it to bottom of can *D* at the right. At the same time, the operator pulls ball *B*, in his left hand, over to the left and puts it down into and touches it to bottom of can *C* at his left.

When the metal balls are put between the two cans and touching as portrayed in sketch, the result is that the 5 lines of electric flux are figuratively, and maybe literally, cut or severed. As a result, the lines of electric field emanating from the positively charged can *C*

terminate on ball *A* and as such constitute a negative charge on ball *A*.

The other part of the 5 severed lines of force reach from negatively charged can *D* and give a positive charge to ball *B*. The metal *B* has thus acquired a positive charge. The balls have been charged by induction, as the phrase is, and not by direct contact with the cans. When the lines of electric force terminate on can *D* at operator's right they represent negative charges on that can. The terminations on can *C* constitute a positive charge. There is still an electric field between cans *C* and *D* but it now consists of two parts due to the cutting of the lines of force by the touching conductors *A* and *B*.

The procedure then, as suggested above, is to pull to the operator's right the negatively charged metal ball *A* over to the right to the negatively charged can *D*. The positively charged metal ball *B* is to be pulled over to the operator's left to *C*. The balls are put down into the cans *D* and *C* rsepectively. When the balls are put down into and made to touch the bottom of the cans, the balls give their charge and electric field to the respective cans. The touching of the charged ball to the bottom of the can can be thought of as tying or fastening the lines of force to the outside of the cans.

Building Up of Charge and Voltage on Outside of Cans

The principle whereby the charged ball gives its charge to the outside of the can when put down inside to touch the bottom of the can is simple and readily understandable. The basic principle is stated formally as follows: there can be no static charge on the inside of a conductor either solid or hollow.

Faraday constructed a 12 foot cube and covered it with tin foil. He went inside with electroscopes. When the cube was charged by static generators so that sparks jumped around outside, he could detect no signs of electrification inside.

In terms of the accompanying sketches, assume the metal can have no charge in the beginning. Now the charged ball is lowered into the can. The 5 lines of force emanating from the 5 positive charges on the ball terminate on the inside of the can and thereby constitute 5 negative charges on the inside surface of the can. This means that there are 5 positive charges on outside surface of can with 5 lines emanating therefrom. The distribution of the charges on the inside surface of the can and on the outside surface of the can is not the same but the total charge is the same as will be observed. As shown, the electroscope will reveal the charge acquired on the outside; see Figure 3.

Now as the ball is lowered, the distribution of the lines of force and

their terminals representing charges will be changed. The field inside represents energy due to the tension in the lines of force. As the ball is lowered, the lines get shorter and shorter due to their contractive character and possess less and less energy. Just before contact between ball and bottom of can is made, the lines are very, very short and there is very little energy in them. At the instant of contact, the 5 positive charges on the ball and the 5 negative charges on the inside surface of the can combine since metallic conduction enables them to do so. As a final result there are no charges on the ball and there is no field inside and no charges within the can. At the moment of touching, the electroscope which has revealed the outside charge, will show no change whatever.

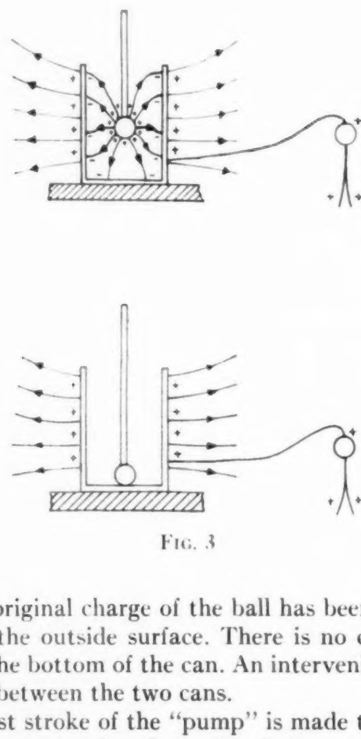

FIG. 3

So again, the original charge of the ball has been given to the can and appears on the outside surface. There is no charge on the ball after it touches the bottom of the can. An intervening field of electric force now exists between the two cans.

Now as the first stroke of the "pump" is made there are 5 lines of force between the cans and each can has 5 charges. The crossed balls placed between the two cans now get 5 charges. Now the newly inductively charged balls with 5 charges each are put down inside of the cans with their 5 charges. The ball *A* with its inductively acquired negative charge is put down into can *D*. The ball *B* with its induc-

tively acquired positive charge is put down into can *C*. The 5 new charges on the balls will be added to the 5 charges already on the outside surface of the cans. By the same process as discussed above, the cans will have 10 charges. There are now 10 lines between the cans. So the charged cans are pumped up in geometric progression fashion with the constant ratio of 2 or 200%. Here lies the reason for calling the apparatus an electric doubler. The number of lines of electric force between the cans increase in geometric progression too. After a while it cannot be assumed that all the lines between the cans are cut when the metal balls are touched between cans. The 200% rate of increase is reduced; the pump is no longer an electric doubler.

As the operator continues to operate the "pump" and do work all the time, the cans acquire a higher and higher charge and a higher and higher voltage and more and more energy exists in the electric field between cans.

It is suggested that the "pumper" be careful not to touch the balls to inside surfaces of the cans when they are taken out of cans. The reason for this care will be discussed later.

The word "pull" was used advisedly and pertinently because the operator had to exert a muscular pull to move the ball *A* over into can *D* and to move ball *B* over into can *C*. As he exerted his pull, he did mechanical work and that energy appears as stored energy in the electric field.

As portrayed in sketch, there are 5 lines of electric flux between cans at the start of the pumping process performed after the priming. After one operation as above described, there would be 10 lines; more pull between charged cans and more energy in the electric field.

As a result of one operation wherein mechanical work was done by the operator, the electric field between the cans embody more electrical field energy, the cans have had their charge increased and the electric voltage between the cans has been increased.

Even though originally, the two cans and the threads *T* and *T′* with their pith balls had a very small charge and little voltage, they now have a bit more of both.

As an end result of this first operation there will be a tiny bit of electrostatic force of repulsion between can *D* and its pith ball and can *C* and its pith ball. The pith balls will be pushed out and the threads will be at an angle outward.

The operating procedure with this training aid is to again touch the two metal balls, with crossed handles in the electric field between the two cans and do the pulling process again, and then do so again; 50 times or so. The pith balls and threads will be pushed out at a sizable angle. This is evidence that work has been done by the operator which work has been transferred to the electrical system. It is to be

emphasized that the operator himself does work in the charging and energizing of the capacitor. It is not a large amount of work measured in foot pounds to be sure. It is not possible for the human operator to sense that energy has been put into the electric field between the two cans. Of course if the operator touches one of the cans with his finger, a tiny spark results. The tiny spark is evidence of energy. However, since the pith balls have been raised to a higher and higher position during the process of pumping, there is visible evidence that work has been done by the "pumper."

Transference of Inductive Electric Charge of Ball to Can

The principle herein discussed and portrayed in sketch Figure 3 suggests an observation to be made appropriately during the "pumping" process.

When the metal balls have been inductively charged by touching them in the electric field between the two cans, it will be noticed that as the balls are put down into their respective cans, the pith balls move out a bit. The electric charge on the cans has been increased by the sheer presence of the charged balls inside of them. When finally the balls are touched to the bottom of the cans, then nothing further happens to the pith balls. The phenomena and principle previously discussed and portrayed in sketch Figure 3 has been exemplified convincingly.

All the time, the operator has pulled and done work. The cans tend to come together due to the pull along the electric lines. The operator is not aware of the pull and his work because it is small. He has cut invisible and intangible stretched electric springs. But something happens after a while. The pith balls move outward farther and farther as the voltage between the cans is built up by the operator.

In the end, the voltage may build up to 20,000 or 30,000 volts. The capacitor has a bit of stored energy. The stored energy (joules) is in the air dielectric between the cans. Since this capacitor has a very small rating in microfarads, only a small bit of energy (joules) is necessary for a high voltage. The extended pith balls show that electric charges and a bit of energy has been stored in the capacity by the operator's expenditure of energy.

That the metal balls give their charge to the cans when placed down inside the cans and touched to the bottom, can now be experimentally illustrated.

It will be observed that both metal balls will be neutral and uncharged on removal since they will attract both positively and negatively charged pith palls. Of course it is the electrically charged pith balls that do the moving. Since both pith balls attract both metal balls, it is proved that the metal balls are uncharged.

Since the cans are open at the top, the charged balls do not give up their charge absolutely and completely to the cans when they touch the bottom but do surrender a major portion.

If care is taken to not touch metal ball to inside surface of can on removal during the pumping process, it will be 99.44% uncharged on removal. It will have given its entire charge to can when touched to bottom of can.

As a simple test relative to this point, it is suggested that the operator touch the metal ball to the inside of the can near the top of the can. It will then be observed that the ball has a bit of charge equal in sign to the can's charge. The ball, charged by this technique, will repel the pith ball attached to the can.

The charge on the ball can be given back to the can by touching the bottom of the can and avoiding contact with the inside surface on removal.

Of course, after the ball has given up its inductive charge, acquired by touching other ball in the electric field between the cans, to the can by touching the bottom of can, it would get a charge afterwards by being touched by the outside of the can. The sign of the charge on the metal ball will be the same as that of the can it has touched. Repulsion of pith ball is the proof.

Some Very Important Sidelights: Charge by Induction

After getting electric doubler well charged and energized, show that if one ball is touched to one can, the ball gets the charge on that can. The recently charged metal ball will repel the pith ball of that can which illustrates the point just mentioned.

The next experimental step is most important and significant.

As metal balls are touched between cans, the mere holding in the field inductively provides each ball with a charge. No contact is made with either charged can but the balls get a charge by induction as the term is. Each ball gets a charge opposite to that of the can it has been near. This idea is a very significant one and reveals the reality of electric field between the cans. This fact can nicely be shown by testing both balls for attraction and repulsion of the two differently charged pith balls.

After the metal balls have been charged by merely touching together in the field between the cans, the balls give up practically their entire charge to the can when touched to the bottom of the metal can. After removal from can, they are practically neutral, and each metal ball will attract both pith balls as per basic truths.

It is important and interesting to appreciate that one cannot get a charge on one of the balls by putting it down inside one of the cans. A ball can be charged by touching it to the outside of a charged can

but again a ball cannot get a charge by being put down to touch the bottom of a charged can. The charged pith ball is the testing instrument for this doctrine.

During the charging of the cans (operating the electric pump) the pull between cans is very small at beginning and increases. Of course it is not large at the end. These cans do not move together on account of friction on the base. If there were just 5 stretched coiled springs, between the cans at the start the cutting of that one and tying can will produce two springs and greater pull. Cutting and tying the cans will produce 10 stretched electric springs and greater pull. Cutting and tying the 10 electric springs would provide 20 springs, more pull together and more energy stored in the electric field. The operator would supply the energy.

Further Observations about "Pumping"

When the balls *A* and *B* are placed between the cans *C* and *D*, the balls inductively get a charge as discussed above. One might ask, why not pull ball *A* over and just touch it to outside of can *C*. Likewise do the same for ball *B* and can *D*. However, in this case the balls would give only a small part of their charge to the cans. The balls would still have a charge, namely that of the can. But by putting the balls down into the cans, they give up practically their entire charge to the can and then when they are withdrawn without touching inside of can near the top, they have very, very little charge and perhaps none at all. They are then ready for the next acquisition of a new and larger inductively acquired charge by being put into the electric field between the cans. The pumping is then to be continued.

As a final result, this training aid has given a bit of reality to a number of concepts. The most important idea that has been illustrated is that of the existence of an invisible and intangible electric field between two charged conductors. Furthermore, a charged capacitor stores energy which in this case has actually been supplied by the operator of the training aid. This stored energy really exists in the electric field between the cans.

The successful performance of this training aid depends on very good insulation. The handles and the supporting boxes were therefore made of polystyrene. If the insulation were poor, the charges might not increase but leak off as fast as they were built up. If the weather is humid, the "pump" will not work very well and maybe not at all.

Modus Operandi—Fourth Step

During the process of pumping, the two metal cans *C* and *D* have been 5 inches apart perhaps. The pith balls are repelled and stay out

away from the two cans. There is an electrostatic field between. The lines have a stretch force along their lengths. They possess energy. The cans tend to come together. If the cans were pushed farther apart by pushing the insulating boxes on which they stand, some work would be done. The pith balls will be seen to extend out farther because the voltage has increased. The capacitance has decreased and some energy has been added. Hence the voltage increases.

When the two cans are moved back to 5 inches apart the pith balls will drop. The voltage between cans has dropped; some energy has been surrendered. This procedure and the visual results again illustrate a very fundamental and simple truth about electric field energy and voltage. The charge on the two cans has not been altered, but the capacitance was increased.

Make this latter test a second and third time.

Effect of Dielectric: Fifth Step

The region between the two charged cans constitutes an electric field. The material or "stuff" between the two cans is, of course, air. The air is called the dielectric of the capacitor. Air has a low value of dielectric constant or specific inductive capacity. Specific inductive capacity is the analogue of permeability in magnetic matters. Dielectric constant provides a measure of yield or compliance to lines of electric flux. If a capacitor with certain area of metallic plates (or cans in this case) has glass, mica, paper, etc., for the dielectric, the capacitance of the capacitor will be increased.

In the present case of the charged cans, the cans have a certain charge of electricity and a certain voltage. If now, two or three books back to back are placed in the space between the cans, the capacitance will be increased due to the greater dielectric constant of paper as compared to air. For air the dielectric constant is 1 and for paper is about 2 or 3.

Since the capacitance has been increased by having the constant of the dielectric increased, the voltage will decrease. Evidence of this fact will be that the pith balls will drop noticeably. The electric charge and stored energy ($\frac{1}{2}CV^2$) has not been changed but the voltage has been decreased. Again it is to be said, that the pith balls will sag because of lower voltage.

When the books are removed, the pith balls will rise to their original position.

The simple relation between electric charge Q, capacitance C and voltage V is given by the formula.

$$Q=CV.$$

If with constant Q, C is increased then V must decrease, but the stored energy ($\frac{1}{2}CV^2$) remains the same. The test with the books nicely illustrates the validity of the above basic and fundamental truths.

The invisible and intangible electric field consisting of lines of electric force as a general concept gets another boost for its articulate reality and existence.

Modus Operandi—Sixth Step

After the operator has operated the electric pump 50, 75, or 100 times and the pith balls are extending out pretty well, the electric field between the cans of the capacitor embodies quite a bit of energy and the voltage between the cans is quite sizable; 20,000 or 30,000 or more volts.

At this point use the accessory item of apparatus consisting of a copper wire attached along a polystyrene rod to discharge the capacitor. Touch one end of wire to one can and then approach the other end of wire to the other can. A tiny spark may jump, showing quite a sizable amount of voltage and a bit of energy. If weather is a bit humid, one may not get a spark even though the pith balls are well extended. If the knuckle of a finger is touched to one of the cans, one may get a tiny shock. The operator or the "pumper" did the work which eventually is evidenced by the small amount of heat in the spark.

Further General Experimentation: Slow Discharging of Capacitor

By use of a glass rod and piece of silk as accessory equipment, it can be readily shown that the two cans have opposite charges after considerable pumping. By rubbing the glass rod briskly with cloth, the glass rod will have a so-called positive charge. The positive glass rod will attract one pith ball and repel the other.

If after the charge has been built up as discussed and the two pith balls are extending out from their respective cans, one can take one of the balls and touch to can D. It will get a charge. Then move the charged ball over to the left and touch can C. Some of the lines of electric flux have been collapsed. The pith balls will drip a bit. After several such operations, the pith balls will noticeably sink. The energy in the electric field has been dissipated; the capacitor can be discharged to any desired amount.

The capacitor can be de-energized as suggested. Furthermore, "un-pumping" or de-energizing can be accomplished by touching balls in the field but not holding them with crossed handles. The uncrossed balls can be put into the near cans and energy will be taken

out of capacitor. De-pumping or discharging has been achieved. The "pumping" process can be resumed after the above partial discharging. The operator may wish just for fun, to "pump" and "un-pump" several times.

Conductivity of Hot Air

The air around the two cans can be made conducting by heating it. One says that heat ionizes the air and thereby makes it conducting.

If a lighted match is held well below one pith ball, the resulting air ions will take away the charge on the pith ball and its can. The pith ball will quickly drop down. The same procedure for the other pith ball will cause it to quickly drop down also.

An Electrical Pendulum

The pith balls attached to the cans *C* and *D* are supported by conducting metallized or tinseled threads. This is expedient in order that the pith balls readily acquire the charge of the cans.

For further experimentation, tie a pith ball at the end of a foot long piece of silk thread. The silk is an excellent insulator.

It is proposed now to remove the metal balls *A* and *B* from the charged cans. The pith balls attached to the cans are slanting outwards due to the repulsion of the pith ball charges and the charged cans as seen in Figure 1.

The next step is hold the pith ball on the end of the silk thread near the cans *C* and *D*. This third pith ball will be attracted to each can. All about the cans, there is an electric field revealed by the third pith ball.

The next step is to let the third pith ball be attracted by the pith ball attached to can. The third pith ball will cling to the pith ball of can *A* at first. After a few seconds, the third pith ball will get a charge and be repelled.

The next step is to bring the two charged cans *C* and *D* up to 2 inches of one another. Now let the charged pith ball hang between the cans so that it is about 1 inch from top. Third test pith ball will first be attracted to one of the cans and will swing over and touch one of the cans and stay there awhile.

After the third pith ball is held a while to can, it will get the charge of that can and swing over to the other can which has an opposite charge. The third test pith ball will stay a while adhering to the can but soon will acquire the charge of that can. As a final result, the third pith ball will swing back and forth as a sort of an electrical pendulum. One might say, one has an electrostatic motor.

The swinging pith ball requires energy to be kept going.

The source of this energy is the energy of the electrostatic field

between the cans. At each swing a bit of the stored energy and a bit of the electric field is dissipated. After some time (one does not know how long), the capacitor will be discharged. The electric field energy will be eventually all gone and the electrostatic motor will stop. The stored energy which is very small will revert to a tiny bit of heat.

As a final step of experimentation, pull the third pith ball away and discharge it by touching with the hand.

Now let the uncharged third pith ball down into either can *C* or *D*. It will be observed that the third pith ball is unaffected. It will not be attracted to the inner surface of the can. As per previous doctrine, this test illustrates the fact that there is no charge and no electric field inside the cans.

If the third pith ball is given a substantial charge by touching it to an ebonite rod which has been charged with a piece of woolen cloth or by a glass rod charged by a piece of silk, it will be found rather difficult to let the charged third pith ball down into the cans. The charged third pith ball will be attracted or pushed aside as one tries to let it down into either of the cans. Of course if one is successful in getting the third pith ball down into either of the cans, the pith ball will swing to the inside surface of the can and cling to the inside surface of the can. There is no charge on the inside of either can so one might say the charged third pith ball does its own attracting for the uncharged inner surface of both cans.

Electrostatic Machines

The electrostatic machine consisting of metal discs on rotating glass plates really develops electrostatic energy by the process involved in the above described simple "gadget." One of these machines is called the Wimhurst generator. The machine involving a continuously moving rubber belt that is used for demonstration and teaching purposes in the Enlisted Department at Fort Monmouth operates on the same basic principle illustrated in the "Electric Doubler."

The man who turns the crank in the above electrostatic Wimhurst generator does work which by the process of "electric doubling of the electrostatic field" enables him to store electrostatic energy and get "sparks" when the discharge is produced.

Electrical Field Energy

Electromagnetic waves are imponderable and are neither animal, vegetable or mineral. Sound waves and water waves are types of mechanical waves involving ponderable matter.

In all wave systems there is nothing physical transmitted. Sound waves in air are not a wind. Water waves are not a rushing torrent. Waves of all kinds convey and transmit a bit of energy. So the im-

portant and basic fact about electromagnetic waves is that they carry energy; one says, they transmit energy.

In the whole gamut of life and natural phenomena, the lightning flash is one of the most realistic and overwhelming. To propound a theory of electricity was a major sport in years gone by. Today we glibly talk about electrons as atoms of electricity. Furthermore, we readily accept the theory that all matter contains electrons. Electrons might be called the building stones of the universe.

It is therefore in order to accept the fact that electricity is an ever present "something." The word "something" was used advisedly and suggested by the observation of a distinguished scientist who said "Our knowledge of electricity relates more to the things it can do rather than to the thing that it is."

We are confronted with the fact therefore, that there is a lot of electricity in our own world and in the universe. It is all about us, it is in everything. Aside from being the "stuff" out of which ponderable matter seems to be made, electricity as such is not worth much to human beings. Unlike water, air and food, electricity as such plays no part in everyday life. It is only when "electricity" offers its talent as a vehicle or carrier of energy, does it pay its astounding role in life.

The interesting and amazing fact about electricity (electrons, if you wish) is that it possesses a field or region of influence in the surrounding space. There is no way to know that a pipe conducting water or air is conducting water and air by examining the outside region of the pipe. But when an electrical conductor is carrying a stream of electrons, the region about the conductor reveals evidence that something is happening in the conductor. When an insulator or nonconductor has an electrical charge, the region surrounding the object exhibits something different from ordinary space.

The most important aspect of electricity and electrons is not the "stuff" itself but the field of influence surrounding the "stuff." This fact is the very unique and characteristic aspect of electrical phenomena as contrasted to all sorts of other physical phenomena.

Our physical life relates very much and very often to energy relations. Work of all kinds must be done; sheer physical work. Energy must be transported from the source of energy to the place that work is to be done. Gas is transported through pipes to cook a meal because heat is energy. Gasoline is transported in the tank of an automobile to do work. Water is transported in rivers and sluiceways to turn the wheels of a grist mill. Compressed air is transported in hoses to operate pneumatic drills to dig up the street.

Water and air as such cannot do work for man. Water must be impounded behind a dam and air must be compressed. So electricity cannot do work except as it is "impounded" or compressed." Elec-

trons and their fields are the great bearers and carriers of energy, but energy must be given to them so that they may serve their amazing role as "carriers." A little bit of water and a little bit of air may possess a lot of energy provided a lot of energy is put into or stored in them. So a little electrical charge and its little electric field can possess a big amount of energy provided a big amount of energy is put into or stored in it. High pressure for water and air, and high voltage for electrons is the answer.

·So finally, then, this training aid called the "electric doubler" offers realistic evidence of the above basic truths. A little charge and a little electric field and a little energy has lent its talent, for the operator of the "doubler" to do the physical work and have that muscular effect translated or transformed and stored into a greater charge and a greater field and a greater amount of energy. One is reminded of the "pump priming" process of a water pump on the farm. It takes only a little water to do the priming. The first little charge and little electric field has served as a starter to the electric pump. The important idea is, that the operator of the electric "pump" must do the work. The "electric doubler" may be thought of as an electric pump. It is very simply "primed" or started. It needs only a little charge for priming.

As an overall observation then, the "doubler" provides realistic evidence of an electric charge, an electric field, lines of electric force and stored electrical energy. The operator of the electric pump has taken part himself in the modus operandi and in the process of getting electricity and electrons impounded and "compressed" so that the electric field will display its energy storage talents. The "doubler" and the "human pumper" has provided realism to the imponderable, the invisible and the intangible.

An Electric Generator Does Not Generate Electricity

It is to be observed that a water pump does not generate water. It is a device which enables a man to pump water and develop a water pressure. The man must do work.

Likewise the electric pump, herein discussed, does not generate electricity. It is a device which enables a man to pump electricity existent in all matter and develop an electric voltage. The man must do work in the pumping and in the establishing of an electric field with its embodiment of energy.

An electric generator is a translator of energy; heat and steam energy or water energy to electrical energy. In some forms of Signal Corps portable generators a man's energy is translated to electric energy to operate a radio transmitter.

"Electricity" is the great carrier and conveyor of energy in electri-

cal power systems and communication systems by wire and radio. In present day life, the number of kilowatt hours and the number of telephone, telegraph and television messages conveyed by electric waves embodying energy are of fantastic magnitude.

Some one, and the writer does not know his or her name, has summed it all up in pretty fashion as follows:

"Electricity, carrier of light and power; devourer of time and space; bearer of man's messages over land and sea; man's greatest servant; itself unknown."

Even though it may be unknown as such, man has learned and knows pretty well how it functions, and what it can do. He had learned how to use it as a faithful, talented and versatile servant.

Incidental Experiment

The two insulator boxes can be readily charged by rubbing with felt or woolen cloth. Another pith ball on a thread will be actively attracted to the box. By pulling it along as it is in contact with the box, it will acquire the same charge as the box. It will then be repelled and actively move away from the box. The electric field above the flat surface of the box will be quite extensive as to region of repelling influence.

Conclusion

One learns a terrific lot in a basic and fundamental way by operating the electric doubler and doing the incidental experimentation. A fairly complete course of study in electrostatics could be built about this one piece of "gear."

HOW TO REMEMBER INDICATOR COLORS

Ralph E. Wellings

Brighton High School, Brighton 35, Mass.

If OH ions present be—
Red Litmus changes Blue, I see.

Phenolphthalein with Red will glow
Where formerly No colors show.

And, likewise, Congo Red; from Blue
Will suddenly change to Reddish, too.

And Methyl Orange from a Red
Becomes a Yellow hue instead.

While Methyl Violet's Yellow tone
Shows a Violet color all its own.

WAYS IN WHICH THE SCIENCE TEACHER CAN HELP STRENGTHEN MATHEMATICS INSTRUCTION*

Ruth Grotelüschen
Haven Intermediate School, Evanston, Illinois

Last week, on November 17, a school news report appeared in *The Evanston Review*, a weekly magazine published in Evanston. "Haven Students Win 16 of 30 Midwest Science Awards." That's really quite a remarkable achievement, I think you'll all agree. We're proud of our science department at Haven Intermediate School and of the record made last spring at the national contest in Cleveland. As a member of the mathematics department at Haven—not science—I'd like to tell you a little more about our science department and how, in my opinion, it complements mathematics instruction.

But first let me tell you about these science awards. At an all-school assembly held the week before November 17, Mr. D. R. Edgerton, who is associated with the American Society of Metals, represented the Future Scientists of America Foundation and presented the science awards. As you probably know, this foundation is a division of the National Science Teachers Association. The Midwest Region includes Ohio, Indiana, Michigan, and Illinois. Two $50 savings bonds and three $25 savings bonds are awarded in each region. Bob Stickney, for his scientific chicken-feeding project, and Janet Nott, for experiments on the value of ladybugs in insect control on crops, each won a first place $50 bond. Joe Herman, for a chemistry project, and Stevenson Swigert, for experiments with chickens, each won a $25 bond. In addition to winning four of the five money prizes, twelve honorable mention certificates were awarded to Haven students. These students were all seventh or eighth graders. Haven is a large school. We have thirteen seventh grade homerooms and eleven eighth grade homerooms this year, an enrollment of 760 students.

The purpose of the school assembly is not only to give recognition to these students for their efforts and achievements and to make the entire student body and faculty aware of what is going on, but also to encourage other students who are or might be interested in science to organize their thinking and get started on a project. And it works, at least for a starter. Too, it destroys forever that stereotyped picture which some boys and girls have of the long-haired, serious, science scholar, because many of these fine looking youngsters could win a popularity contest as well as one in science.

* Read at the Junior High School group program of the Central Association of Science and Mathematics Teachers, Detroit, November 26, 1955.

And why was I, a mathematics teacher, impressed and pleased? In what ways does the science teacher help strengthen mathematics instruction? I think there is no doubt about the fact that science teachers do, consciously or unconsciously, directly or indirectly, strengthen and give meaning to mathematics instruction. The more conscious and direct the approach, the more effective the total program of science and mathematics.

Since last spring when Miss Hach asked me to participate in this discussion, I've been unusually cognizant of the relationships between these two subject areas, and perhaps that has been the reason why I have been almost frightened by the lack of awareness of these relationships on the part of so many teachers. Generally speaking, and I know that's dangerous, the science teachers are all too often apt to gripe, saying that it would be easy to teach the chemistry or the physics or whatever it might be if only the students knew how to add, subtract, multiply, and divide. And the math teachers are apt to have the mistaken notion that without them there would be no science. Of course, I'm exaggerating both attitudes, but if only we could all see more objectively how dependent each is on the other, we'd make things more meaningful for our students. Now when we hear so much about the unification of two or more subject areas, core programs, etc., it is even more essential that separate departments of mathematics and science work cooperatively.

I realize, as do you, that in some schools math and science are combined, taught by the same teacher, etc. At Haven our unified studies includes the social studies, literature, English, reading, and spelling skills. But unification of the separate departments can be accomplished without long, drawn-out, joint department meetings. Very probably we achieve a more functional kind of unification if only the two teachers involved with any given group confer informally but regularly about that group. "Where are you in math?" "What do these students know about percentage?" "Can they apply it to this or that situation?" Or, "John is working on a scale drawing of the solar system, but he's got it way off the paper. Will you help?" And the teachers can also confer with the students themselves. Students then begin to see a more complete picture of what education really is, and mathematical knowledge and skills become useful tools and science becomes something more than fiction.

When students feel free to bring problems from the science class to the math class, the math teacher ought to capitalize on the opportunity given him and make the most of it. Never, *never* squelch the request for help with "We haven't time," or "We'll study about that next month," or "You were taught how to do that last year." The time is right then to give meaning to a mathematical concept or

process or to clarify an application of the concept or process. If the math teacher doesn't do it, the science teacher must or the student becomes more confused then ever.

Particularly in the field of measurement, linear, square, cubic, measures of weights, measures of time, does the science teacher strengthen mathematics instruction. How many math teachers have been utterly discouraged when a student, given the problem, "Find the perimeter of a sheet of paper $8\frac{1}{2}$ in. by 11 in.," gives as his answer 39 sq. in.? Or "Mrs. Dee's kitchen measures 9 ft. by 12 ft. It is covered with linoleum costing \$1.50 per square yard. What was the cost of the linoleum?", and the student says, "\$54," thinking $9\times12\div3$ instead of $\div9$?

The student who built the chicken coop for his science project made no such errors. Why? There are many possible answers: he was dealing with a real situation; an error would cost him not only in money but also in wasted time and effort. Think of the math involved in building the chicken coop which housed the chicks during the time they were kept at school. What were some of the things to be considered?

Volume—cubic inches of air space necessary for each chick
Area—floor area necessary for each chick
Dimensions of each compartment
Cost of materials—lumber, wire, etc.
Weight of lumber
Mobility of finished coop

And math was used in other ways as this project continued. The weekly weight charts and food and water consumption charts for each of the three groups of chicks, a control group, a high protein group, and a low protein group, were carefully and accurately calculated. The first one explains in detail the processes involved. "To find how much food is consumed I use the following method," and he tells it exactly. Being a math teacher, I'm a bit curious as to why in his first division he changes his quotient 6.125 lb. to $6\frac{1}{8}$ lb. and in the second one he leaves $6.3\frac{1}{3}$ oz. just as is, $6.3\frac{1}{3}$ oz. But on the weekly charts he has, for the most part, used decimals and to the nearest thousandths. Also I wonder why he has used long division to divide 38 by 6. He wouldn't have in math class. I rather imagine that he did it in such detail for the benefit of the judges at the contest.

Students learned the importance of accuracy too. Eggs were hatched at school, and the thermostatic controls of the incubator gave those in charge of it a great deal of trouble. The first time they had hard baked eggs, the eggs got chilled on the second try, but success came at last.

Time measurement was also involved. After a certain length of

time they even opened an egg each day and timed the life of the embryo at the various stages of development.

An hexagonal coop was also for chicks. Originally it was designed to eliminate the right-angled corners into which chicks tend to crowd and smother. The boy who built it won a $25 bond, but the prize was, I think, awarded primarily on the experiments he did with the chicks rather than for the coop. It looked like a jolly good one to me, but the boy who built it doubted its practicability.

I have shown you this photograph of the "Chemistry of Candy" poster. You're probably wondering how that is supposed to strengthen mathematics instruction or if I brought it along just because it was so attractive. Actually there was a considerable bit of math in the essay that went with it, but I brought it along for quite another reason. I don't know whether the girl who did the project could construct the lines of symmetry in a given rectangle or not. But I am sure that when she balanced this chart so artistically, she never once thought of the word "symmetry." She apologized for the line in the center when she gave me the photograph. It didn't show so plainly on the large chart itself. The samples were mounted on two large poster boards which were then fastened together. Unfortunately, she thought, the camera picked up that line. I think it a fine example of line symmetry, but it would have strengthened math instruction more had she and the science teacher thought so and called it by name.

The work which the science teacher does in connection with formulas can also strengthen mathematics instruction. One can find many examples in science texts which illustrate how meanings of formulas are established by experimentation with real things rather than with abstract concepts. A seventh or eight grade student may not be able to give the formula for changing degrees Centigrade to degrees Fahrenheit; but he very probably can give a close approximation of the correct temperature on the Fahrenheit scale because he has worked with both kinds of thermometers. He knows that the freezing point of water is 0°C. and 32°F. He has examined tables of the melting points of common materials given in degrees Centigrade and in degrees Fahrenheit. He sees the relationship of the readings. He has answered questions such as, "The temperature of the human body is 98.6°F. What is the temperature in degrees C.?" With the knowledge and understanding he has gained by this kind of experimentation, he will more easily understand the meaning of the formula when it is presented to him.

The boy who builds a power-driven truck must work with formulas to find the voltage required to make it run, and activities such as that are fine. They lessen the chances ot his acquiring facts and knowl-

edge as ends in themselves. Some boys and girls become so fascinated with the scientific terminology and with the manipulation of figures that they completely lose sight of the scientific and mathematical principles involved. I think there is real danger in this. Particularly so because it is often the *good* student who will, without sufficient guidance and direction, grasp a bit of knowledge here, a bit there, and use it to impress his peers and even his teachers. That kind of attitude is incompatible with the present need for creative mathematicians and scientists in industry and education.

Last spring I was discouraged when I saw some science papers of one of my better math students. The student was greatly impressed with them. He saw so much in them that wasn't there. His "Proof of Ohm's Law—$E=IR$," "Proof of Power Law—$W=I^2R$" were disconcerting. What he has here (papers) are no proofs. He has merely substituted given values in a given formula and found the missing value. Did he see the relationship between $E=IR$ and $A=lw$, $I=E/R$ and $l=A/w$? No, he did not. These relationships must be pointed out and so must the meaning of "proof." Then the science program really will strengthen the program in mathematics to an ever greater degree.

As I have been pointing out only a few of the relationships of science and math at the seventh and eighth grade level and ways in which the two departments can work together, you have probably thought of many other and better illustrations which I might have used and other and better ways for the two departments to work together effectively. That's all to the good, for if we are mindful of the relationships, we can and will strengthen instruction in both fields.

GREATER NEWARK SCIENCE FAIR

Plans for the third annual Greater Newark Science Fair to be held at Newark College of Engineering April 13 and 14, were announced today by William Hazell, Jr., Committee chairman.

A total of 131 public, private, and parochial junior and senior high schools in the five counties of Essex, Union, Hudson, Morris, and Passaic, plan to exhibit at the Fair, with a predicted increase by the Committee of as many as fifty exhibits over the 165 shown last year.

Students will display their projects, the result usually of five months' work, at the College's Laboratory Building, 367 High Street, Newark, before a special judging committee on Friday, April 13. The Fair, including winning displays, will be open to the public on Saturday.

Dust Mop with a flexible plastic handle enables the busy housewife to dust under beds and radiators with almost no bending. The mop head is color fast. This lightweight household aid also protects furniture by minimizing scratches.

A LECTURE TABLE THERMOMETER AND VOLTMETER

FREDERIC B. DUTTON
Michigan State University, East Lansing, Michigan

One of the more difficult problems faced by those interested in giving good science demonstrations has been the indication of temperature changes to a large group. This problem has frequently been solved by calling on a student from the class to step up and read the usual small, laboratory thermometer. It has the obvious disadvantage that only one person can make the actual observation for himself,

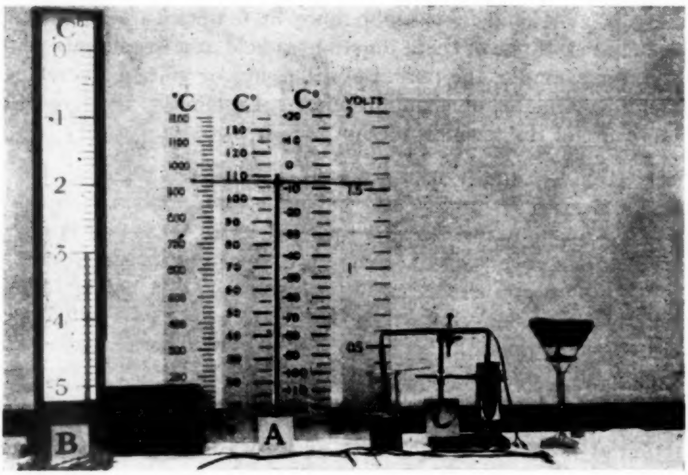

FIG. 1. Lecture table thermometer. Foreground, thermocouples; *C*, ten-junction thermocouple mounted for freezing-point-lowering measurements; *A*, alternate scales; *B*, extension cord for thermocouple or cell connections: extreme right, funnel for separating ice from solutions.

and in addition there is a certain amount of distraction caused by the inevitable interruption of the experiment. To solve this problem it was decided to build a thermometer which would have a scale illuminated by a four foot fluorescent lamp, the temperature indication to be made by having an indicator move up and down this scale in proportion to the temperature change observed. Instruments which are capable of indicating and recording this type of information have long been available to industry in various forms, but possibly because of cost, or more probably because of inertia, they have not been introduced into the classroom in a manner commensurate with the advantages which they obviously possess.

Thermocouples, resistance thermometers, and thermistors are all available as temperature sensitive elements for this type of application. The thermocouple was selected for use in this application because of its ease of construction, economy, and the fact that its output may be measured with a potentiometer, making the instrument equally adaptable to the measurement of the voltage of batteries and electrochemical cells. One basic instrument thus becomes a thermometer and voltmeter simultaneously.

A thermocouple is formed when two wires of dissimilar composition are joined at two different points and each of these junctions is maintained at a different temperature. If the circuit is opened, the potential difference between the two points thus formed becomes roughly proportional to the difference in temperature between the two junctions. If one of these junctions is held at a fixed temperature, or 0°C. for example, the potential difference or voltage, as recorded on a milli-voltmerer or a potentiometer, becomes a measure of the temperature of the second junction.[1]

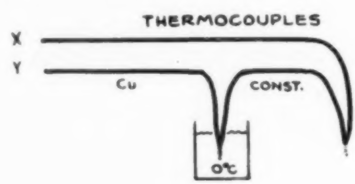

FIG. 2.

If two dissimilar wires are joined as shown in Figure 2, and the junction at A is held at 0°C. with an ice-water mixture, a potential difference or voltage will exist at points X and Y which will be proportional to the temperature at B. This relationship is not quite linear and, consequently, reference must be made to a calibration curve or to tables which are readily available in handbooks and other such reference sources. The potential difference between X and Y may be measured with a very sensitive milli-voltmeter or preferably with a potentiometer since the latter, when in balance, draws no current from the system. The sensitivity of such a system can be increased by arranging a number of junctions in series as shown in Figure 3. The output voltage at X and Y then becomes equal to that in the first example, multiplied by the number of junctions which are in series. As will be shown later, this device has been resorted to in order to make temperature measurements in terms of a few hundredths of a degree. Our problem now becomes one of translating the

[1] A good reference on thermocouples is "Thermoelectric Thermometry," by Paul H. Dike, Leedo and Northrup Co., 4907 Stenton Ave., Philadelphia 44, Pa. Cost $1.00.

electromotive force or potential difference between points X and Y of our thermocouple into degrees C. on the four foot scale mounted in front of the fluoroscent lamp. This is where we resort to the facilities made available through industrial instrumentation. The schematic system is indicated in the diagram shown as Figure 4. The output of the thermocouple is balanced against that of the potenti-

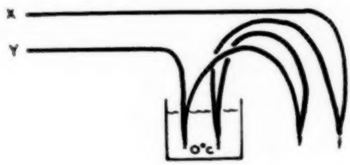

FIG. 3.

ometer, and in series with this system is the convertor amplifier. The convertor changes the direct current to alternating current. The amplifier, as its name implies, amplifies the signal which is then transmitted to the motor, causing the motor to revolve in one direction or the other depending upon the direction of unbalance of the system. The mechanical arrangement is such that, as the motor drives, it changes the resistance within the potentiometer and brings the system into balance so that no current will flow and the motion of the motor ceases. The position of the indicator on the scale then corresponds to the temperature which is being measured. The details of this circuit have been published elsewhere.[2] By changing the particular thermocouple used, by varying the number of thermocouple junctions, and making appropriate changes in the resistances within the potentiometer by means of a range switch, various temperature ranges may be measured.

To illustrate the use of this instrument which is shown in Figure 3, we will start with the 0 to 1200° scale in place, select the appropriate resistance with the range switch on the control box, and connect a single-junction chromel-alumel thermocouple. Inserting the fixed junction in a water-ice mixture, we can use the other junction as a probe to measure any temperatures between 0 and 1200°. For example, we may determine the difference in temperatures between various zones in a burner flame. If we now change the scale to +20° to −130°, we will have to substitute water at 20° for ice at the fixed junction, select the appropriate resistor combination in the control box and attach a single-junction copper-constantan thermocouple. With this arrangement, we may measure any temperatures from

[2] *Journal of Chemical Education*, Volume 32, page 478, September, 1955.

room temperature down to $-130°C$. For example, we may take the temperature of a sample of dry ice which is approximately $-78°C$.

We have perhaps made the greatest use of this instrument in demonstrating the lowering of the freezing point of a solvent by the introduction of a solute . For this application we will insert the 0° to $-5°$ scale, again select the appropriate combination of resistors with the range switch, and substitute a ten junction copper-constantan thermocouple, for the one previously used. Again inserting the fixed junction in an ice-water mixture, we are now prepared to measure the temperature of solutions within the temperature range which we have available. The technique used in this experiment is essentially that observed by the speaker as performed by the late Professor Rumold at Kent State University, Kent, Ohio. As he carried out the experiment, temperatures were recorded by observation of the usual laboratory thermometer. This device greatly facilitates the operation by making the temperature reading visible to all the students in the room at once. A known weight of solute is dissolved in water, the solution poured over crushed ice, and the temperature observed until no further change takes place. This is assumed to be the equilibrium temperature for the system. The ice and solution are rapidly separated by pouring the mixture through a large funnel which contains a wire screen. The solution is weighed and we have the following data, for an example using 23 grams of ethanol or ethyl alcohol.

Weight of beaker plus solution	788 g
Weight of beaker plus solute	248 g.
Weight of water	540 g.
Weight of solute	23 g.
Molecular weight of solute	46
Freezing point of solution	−1.72

$$\frac{23 \text{ g. solute} \times 1000 \text{ g. water}}{540 \text{ g. water}} = 42.6 \text{ g. solute}/1000 \text{ g. water}$$

$$\frac{42.6 \text{ g. solute}}{46 \text{ (mol. wt.)}} = .925 \text{ molal}$$

$$\frac{1.72}{.925} = 1.8 \text{ molal freezing-point constant}$$

By the use of other solutions which are non-electrolytes the freezing point constant of water may be shown to be a property of the solvent.

With this constant established the technique may be used to determine the molecular weight of an "unknown" solute. In a similar manner the apparent degree of ionization of electrolytes may be determined.

If a zero to two volt scale is used in place of the temperature scales, leads carrying battery clips inserted in place of the thermocouple and the appropriate range selected, we may use the device to measure the

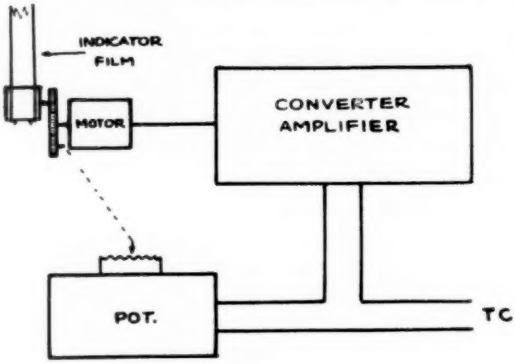

FIG. 4.

voltage of a battery, such as an ordinary dry cell or an electrochemical cell which is made up with suitable metal electrodes and the appropri-

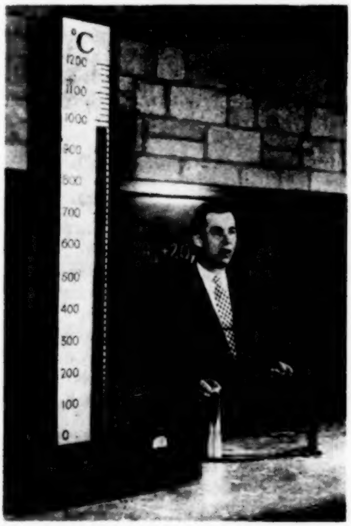

FIG. 5. Measuring flame temperature.

ate electrolytes. With a suitable range of resistance available, this device could be hooked up to a pH meter to indicate pH or hydrogen ion concentration.

This instrument as constructed by us could be duplicated by anyone who has access to shop facilities. The purchase price of materials would come to perhaps two hundred and fifty dollars. It is not available from apparatus supply houses and probably will not be unless one of them becomes convinced that there is a sufficient market for it.

Acknowledgment should be made to Dr. R. J. Jeffries of the Electrical Engineering Department of Michigan State University for suggestions which made the device practical, and to Dr. H. B. Thompson of our laboratory for advice freely given.

A WORKSHOP FOR SCIENCE TEACHERS

A plan for contributing to a more adequate supply of well-trained high-school teachers of science will be initiated next fall at a year-long workshop at Teachers College, Columbia University. The workshop will be given with industry cooperation. It will be designed for professors at teacher-education and liberal-arts colleges that prepare science teachers. Its long-range goal is to make possible more scientists, engineers and other technological personnel through the more effective education and guidance of students in high-school science courses.

Dr. Caswell, president of the college, said that "this move represents an attack on a highly important phase of the science-manpower problem. An adequate supply of well-trained high-school teachers of science and mathematics is the foundation of the program to provide our country with needed scientists and engineers. The teacher of these teachers is a key factor in building this foundation."

The workshop will start Oct. 1, 1956. From twelve to eighteen colleges will be represented. It will be financed by industry and Teachers College.

The cost for the first year is $79,000, of which $20,000 will be underwritten by the college. The remaining $59,000 will be given by corporations, industry and foundations. About $35,000 already has been given or pledged by the latter sources.

It is hoped that four additional workshops can be set up at Teachers College through 1961. The college believes that it will take at least five years for the program to make itself felt.

In that time, workshop members will have introduced the results of their work in their own teacher-education colleges and have begun to train science teachers along the lines developed at the workshop. These teachers will be able to do a more effective job of teaching science and cultivating gifted students for technological careers.

Contributions or pledges for the wort workshop have been received from the Alcoa Foundation, American Gas and Electric Company, the American Metal Company, Ltd., the Armco Steel Corporation, the Auto-Lite Foundation, the Continental Can Company, the Crown Zellerbach Foundation, the General Dynamics Corporation.

Also the Gillette Company, the International Nickel Company, the Pittsburgh Plate Glass Foundation, the Procter and Gamble Fund, the Rohm & Haas Company, the Sperry Gyroscope Company, the Standard Oil Company of California, the Standard Oil Company of New Jersey, the W. M. Welch Manufacturing Company, and the West Virginia Pulp and Paper Company.

The workshop will be sponsored by the Department of Teaching of Science of Teachers College. Its instructors will come from that department and science departments of Columbia University. Policy will be made by an advisory board representing Teachers College and industry.

The main goal of the project is to contribute to the solution of one of the nation's most serious problems, which is to attract a larger number of able young people and train them for technical careers.

NECTAR FOR THE SCIENCE BEE

WILLIAM D. FRITZ
Highland Park High School, Highland Park, N. J.

Despairing science educators throughout our nation are vociferously expressing the deep concern they feel for the decrease in science enrollments in the secondary schools of this country. These people are aware that in order for America to maintain industrial leadership and economic security she must be provided with a continuous supply of young scientific talent. As a result of an ever changing technological society it is now imperative that all science educators assume the responsibility of determining how to help improve this situation.

The trend in enrollment in chemistry and physics classes at the secondary level must be encouraged upwards, but the question arises, "How can I, as a science teacher, help reverse the enrollment trend in my own practical situation?"

Business uses a number of simple formulae to sell their products. They determine the need for a particular article; then they bring the article before the public by appropriate advertising; by suitable displays the customer is lured into the store and a certain number will buy. While the customer is in the store he is treated with every courtesy; "He is always right." These same advertising principles can be applied to your science program.

High School physics and chemistry courses are largely elective. A technique that can be used to bring more students into the science program is to find out what students do not like about teachers and about different courses and then refrain from doing the things that students dislike; providing, of course, that this procedure does not entail a lowering of standards of student achievement. It is undoubtedly a good idea to fit the course to the students' needs, if it is possible to discover these needs. This might attract some students to less theoretical science courses, who would not enroll in the college preparatory course in physics or chemistry. We at Highland Park High School find the "two track" plan in physics and chemistry of definite help in reaching students who otherwise would not elect a science beyond general.

A recent survey* has been conducted to determine what students do not like about teachers and courses. A few items are listed below with suggested remedial action to be taken by the teacher.

"Lack of teaching efficiency, failure to meet student needs, do not put subject matter across, or facilitate learning."

* Bradley, G. H., "What Do College Students Like and Dislike About College Teachers and Their Teaching? *Ed. Adm. and Sup.*, 36: 113–20, Feb. 1950.

Know what you are going to do before going to your class.
Have your laboratory ready for your students.
Have your demonstrations set up and ready to go.
Does your demonstration teach what it is supposed to?
Be sure your projector is "ready to roll."
Don't try to teach non-college preparatory students "watered down" courses without any laboratory or demonstrations.
Be sure you know and understand your subject matter before you try to teach it; you may think you are fooling the students, but you are only fooling yourself.

"Have an unpleasant personality, hard to get along with; temperamental, arrogant."

Do a bit of self-analysis. Do more than one of these traits apply to you? Correct the deficiency.
You can be pleasant much more easily than unpleasant and it is much more fun.
Are you arrogant because you are not master of your subject? Do enough studying in your subject area to be its master or consider changing to another area of learning.

"Tests poorly constructed and administered."

The chief difficulty in test construction is the ambiguous question. Does it have two or more possible answers? If it does, formulate a new question. Consult the many published tests for examples of good questions.
There are many standardized tests in the field of science; pick one you like and use it.
Use the tests furnished with your text or work book; you may not like them but I dare you to find enough time to prepare better tests.
Be sure your test questions are taken from material which you have taught.

"Marks not given on a scientific and impartial basis."

Determine a student's grades on the basis of test results alone, and not on what you "think" a student deserves. Administer six to nine tests over a six week marking period and average the test grades for the student's marking period grade.
Tell the students how their grades are determined.
Inform the students when a test will be administered.
Be sure you test on what you have taught and that the test is used as a teaching device.
Use "homework," laboratory activities, demonstrations, explanations and class discussion as teaching devices to assist the student in mastering his subject.
Administer a "*fair*" test and let that grade be the measure of the students' mastery.

The Highland Park High School enrollment in physics in 1949 was 27.5% of the total class, in 1955–56 it was 42.9%. The enrollment in chemistry in 1948–49 was 30.2% of the total class, in 1955–56 it was 55.3%. The above percentages indicate a reversal of the generally accepted enrollment trend. We in the science department of Highland Park High School believe that this enrollment trend reversal is the result of using the techniques described above through our entire science program—beginning with the very strategic ninth year study

of General Science, continuing in tenth year Biology, eleventh year Physics and twelfth year Chemistry. We believe that students are attracted by encouragement in their work and good sound teaching techniques. This philosophy permeates the thinking of our science faculty and it is the flower that furnishes the *Nectar that Attracts the Science Bee*.

SIMPLE HARMONIC MOTION AND INDUCED EMF

Julius Sumner Miller
El Camino College, El Camino College, California

An instructive exercise both analytically and experimentally is provided by the following arrangement: Support a simple harmonic motion (spiral) spring vertically. To its lower end fix a strong bar magnet. In the equilibrium position let the lower end of the magnet rest in the center of a coil of wire which is connected to the lecture galvanometer. (An appropriate coil may consist of a hundred or more turns of No. 30 copper wire wound so that the central hole is large enough to admit the magnet freely). If, now, the magnet is displaced vertically it executes simple harmonic motion. Its maximum velocity is proportional to the amplitude which is proportional to the rate of change of flux. If the magnet is drawn down a *measured* distance d (cm) and let go the galvanometer reading θ may be observed. A succession of readings may be taken for various values of d. The plot of d against θ yields a straight line whose significance is clear.

MICHIGAN COUNCIL OF TEACHERS OF MATHEMATICS

The Seventh Annual Conference of the Michigan Council of Teachers of Mathematics will be held at St. Mary's Lake Camp, Battle Creek, on May 4, 5, and 6, 1956. Registration will start at noon on Friday, May 4, and the conference will close with dinner Sunday noon, May 6.

There will be four general sessions and numerous smaller discussion sessions. Discussion groups have been planned for teachers in the elementary schools as well as for those teaching in junior or senior high schools. Dr. Howard Fehr, Head of the Department of Mathematics at Teachers College, Columbia University, will be the principal guest speaker and consultant. He will participate in the general sessions and also in the discussion groups. Other speakers at the general sessions include Mr. Conway Sams and Dr. Fred Beeler of Western Michigan College and Dr. Harold Larsen of Albion College.

St. Mary's Lake Camp is pleasantly situated on St. Mary's Lake, four miles north of Battle Creek. Recreational facilities are provided, meals are served in the main dining hall, and there are dormitory type sleeping accommodations for about 150 persons. Hotel accommodations are available in Battle Creek for those who prefer them. The charge for the conference (including all accommodations) is modest, and members of the Michigan Education Association are entitled to a substantial discount. Inquiries or requests for information may be addressed to Miss Murel Kilpatrick, 114 North Hamilton St., Ypsilanti, Michigan.

A SCIENTIFIC DILEMMA

Orval L. Petersen
Chief Kamiakin Junior High School, Sunnyside, Washington

Many people sometimes mistakenly think that all the problems of our physical and natural world are within the realm of ultimate solution by scientists provided that scientists are given the tools and the time to study them. Such a conclusion is erroneous and unfair to the scientist. He, as a human being, does not and can not possess the biological means to discover the ultimate true nature of the universe and the environment in which we live. Whether we desire it or not we inescapably live in a world of limited sensory perception which all too often leads us into resultant deceptions. This is our inheritance from Nature itself. We cannot appreciably change it.

The scientist, when he is attempting to learn more about the phenomena everywhere about him, must tackle problems confronting him hampered by numerous handicaps which he can never hope to overcome. Everything we as individuals learn must be acquired directly through sensory perception. We learn to recognize what something looks like because we are able to perceive a visual image of it by observing it. But the sense of vision in human beings is not accurate as countless experiments have shown. No two people can ever simultaneously visualize things alike through direct observation of them. The sense of vision is limited by its biological construction but other factors are active as well. Shadows present, amount of light, angle of view, distance, along with other facets such as that no two people can ever be in exactly the same spatial location at the same time when observing a particular phenomenon are important. Thus no one can possibly ever see just precisely the same thing that is seen by you. Further, it becomes virtually impossible to prove absolutely that what one person sees visually is identical to that seen by another observer. For example, when a small child sees a color such as green he is told by his mother that this particular color is green. Therefore, after that time whenever he sees what appears to him to be that same color he calls it green. He, his mother and others have agreed that green will stand for the name of that specific color. But how can anyone ever really know for certain that what one person sees as green is precisely the same as what another person sees as green? In fact, how can we ever know that any observable thing at all is identical to others as it appears to us except by arbitrary mutual agreement? This lack of accuracy in visual acuity and perceptive power places an everpresent limitation upon the scientist and his quest for ultimate truths.

Additionally, the scientist must describe his observations and findings by means of either the written or spoken word. As a tool in this regard he has a vocabulary of man-made words or symbols to use. Many of these words prove inadequate for how can one verbalize the sound of the wind through forest pines or the feeling one obtains through watching an unusually spectacular sunset? The result is that new words are often invented to describe new sounds, sensations, and other types of phenomena. This raises more problems such as the one of interpretation which in turn raises other problems. One of these, for example, is that words must be used to define words or to interpret new ones each of which requires further definition and interpretation—a never-ending cycle of interpretive confusion.

Another way the scientist learns and makes discoveries is through using the sense of touch. But this particular sense is even more inaccurate and inadequate than the two mentioned previously. As a simple example, a person relying on touch alone is generally unable to tell positively whether something is hot or cold when it is momentarily placed at the back of his neck.

But of all the senses, taste and smell are the least sensitive. Scientists rarely depend on them alone. Indeed, most scientists use most or all in combination whenever attempting to discover a physical truth or solve a problem. Thus it becomes increasingly obvious that scientists as a specialized group or any other human being for that matter will likely never be able to fully comprehend nor learn nor convey all that remains in our physical universe yet unlearned and undiscovered to one another or to anyone else. To the scientist these limitations of sensory perception are most perplexing. They are rarely recognized by the non-scientist. How will we ever know whether or not there are phenomena which exist about us undetectable to our senses? Other factors directly or indirectly allied with sensory perception produce still other problems.

If we listen to different sounds we discover that the ordinary human ear is sensitive enough to detect only those vibrations in a frequency of about 14 cycles per second to somewhere around 14,000 cycles per second depending upon the individual listener. This limitation in range proves to be both an asset and a handicap. If, for example, each of us could hear every possible sound existing from the very highest to the very lowest we would likely collapse in a state of hopeless confusion for we would hear sounds such as radio waves, television sound, animal noises and the like simultaneously in addition to the ones we ordinarily detect. Nature's lack of construction of a highly sensitive eardrum prevents this from happening. At the same time it prevents the layman and the scientist alike from ever hearing new and different sounds beyond those in the

frequency limit we can normally detect. Therefore, the scientist is inescapably limited to what he can learn about sound for he must change sounds which are outside his limit of auditory perception in such a way as to make such sounds either audible or visible that he may study them. In the process of making such change it is likely that some distortion of the true sound as it exists normally in nature takes place. To prove whether or not distortion does or does not occur in this regard is another problem in itself.

Another factor limiting scientific investigation is one closely allied to that of visual perception. Most of what the scientist learns he learns through auditory or visual means and usually through the combined utilization of both. Individuals can see only what is reflected to the eye within a certain limited range of wave lengths. Light of wave lengths not within this range is not visible to us. If it were possible that our visual perception was of greater scope we would be hampered in observing anything at all for we would have to constantly be looking through a screen of natural radioactive particles, x-rays, cosmic rays and the like. On the other hand by being unable to see those things which exist beyond our visual limits we can never hope to learn the absolute or wholly true nature of light or anything else about us.

Thus, scientists must and do devise test instruments and experiments to alter or change such things as light and sound, for example, which are not within the realm of human sensory perception into a form which makes the observation or hearing of such phenomena detectable to our physiologically imperfect senses of sight and hearing. The one great dilemma of the scientist is that he, as a physical being, will never know for absolute certain if or to what extent he is altering natural phenomena when he changes them into observable form. It is possible that what he sees on test instruments is nothing at all like what the thing under study is like in its natural state. Whether it is appreciably changed by its actual study and to what extent or degree is an everpresent unknown. In any event, the primary problem still remains that everything studied or contemplated by the scientist is based completely upon his imperfect sensory perceptions and his individual interpretations of them.

In final analysis it would appear that the biological and physiological construction of the human individual by Nature itself has decreed that depth and scope of man's learning be held within certain rather well-defined limits. For is it not true that how much man knows about the world in which he lives is not nearly so important or significant as to what uses and purposes he applies the knowledge he has?

ORGANIC DEMONSTRATIONS—A NEGLECTED OPPORTUNITY

Ralph E. Dunbar
North Dakota State College, Fargo, North Dakota

The use of lecture demonstrations as an aid in teaching college inorganic chemistry, or even as a partial substitute for individual laboratory work, has been practiced and generally accepted for years. Perhaps the somewhat erroneous impression that all organic reactions are necessarily extremely slow has mitigated somewhat against any similar attempt to apply lecture demonstration techniques to the teaching of organic chemistry. Fowles (1) has prepared a comprehensive and useful volume on lecture experiments, and while the contents are devoted exclusively to Inorganic Chemistry, many of the ideas and principles may be adapted to organic instruction. Older and similar books have been written by Benedict (2), Davison (3), and Newth (4). A similar and more recent tabulation by Arthur (5), on lecture demonstrations in general chemistry fortunately contains a lengthy chapter on Organic Demonstrations and this volume is recommended to instructors for careful consideration. Hartung's (6) book on the screen projection of chemical experiments contains many unique and helpful suggestions. The *Journal of Chemical Education* (7) and School Science and Mathematics (8) frequently published valuable material for organic lecture demonstrations.

A critical study and evaluation of typical organic reactions will show that many are rapid enough to be used effectively as lecture demonstrations in organic teaching. Likewise, the equipment and, techniques usually required are sufficiently simple to provide rapid presentation and clarity of the organic principles involved. Many typical organic laboratory manuals include a vast assortment of brief test-tube experiments, and while these are desirable in themselves and illustrate important principles they seem to encourage "dry-lab" practices on the part of many students. As a result, many instructors prefer the longer and more elaborate preparations that produce final organic products. However, the importance of these briefer reactions should not be minimized and the lecture demonstration method may be a partial solution.

The same basic principles of effective teaching, good techniques, and clarity and correlation of subject matter and demonstrations should be observed. The following suggestions are appended, as applicable not only to organic demonstrations but to any other similar situation:

1. *Apparatus should be on a large scale.* Use small beakers or similar containers instead of test tubes where applicable. One and five pound

salt bottles are frequently useful. Use equipment large enough to be seen from the farthest corner of the room.

2. *Apparatus should be as simple as possible.* Usually large trains of connected apparatus, such as complex distillations, are too involved and time consuming to be practical.

3. *The preparations and experiments should be carefully arranged.* The equipment should be placed in order on the lecture table so that the demonstrator can proceed logically from one demonstration to the next. The apparatus should be placed well forward on the desk, facing outward toward the students who are to observe the procedure and results.

4. *Experiments should stimulate further thought.* Acetylene burns with a luminous flame while methane does not. Why? Ethanol will produce iodoform while methanol will not. Why?

5. *Positive effects are more effective than negative.* Bromine solution reacts readily with unsaturated hydrocarbons as contrasted to saturated hydrocarbons. Similarly, phenol reacts with bromine more readily then benzoic acid.

6. *A slight dramatic element is sometimes useful.* The production of azo dyes from comparatively colorless solutions is rather spectacular. The precipitation with aicd of synthetic rubber from a stabilized latex is effective.

7. *An element of the unexpected is sometimes effective.* A number of plastic foams are now available that produce surprising effects. The addition of saturated calcium acetate solution to ethanol produces a rigid gel.

8. *Experiments should illustrate principles of some importance.* The combination of an acid and alcohol produces an ester, frequently of pleasant odor. The dehydration of alcohols frequently produces an unsaturated hydrocarbon.

9. *The speed of action should be suitable.* It must be admitted that many organic reactions are too slow for practical use. However, slight modifications may frequently be made, for aniline is readily acetylated with acetyl chloride but not with acetic acid.

10. *Experiments should be as nearly infallible as possible.* Difficult or doubtful experiments should be rehearsed in advance and all variables carefully controlled to guarantee success. Too high a temperature may lead to failure in the preparation of an azo dye.

11. *The demonstration should be a model for the pupils in clearness, vividness, and good form in presentation.* Good techniques on the part of the demonstrator will stimulate better laboratory work for the pupils. The outline for discussion should be carefully planned and well executed. Conclusions should be logically deduced and accurately and clearly stated.

The following brief suggestions have been gleaned from a long list of possibilities and are typical of many others that might be devised by any creative teacher. The demonstrations are grouped according to typical and traditional organic subdivisions. The directions are purposely brief since the techniques involved are typical of organic procedures, and are well known to practicing organic chemists. Demonstrations that require elaborate equipment, continuous trains, or excessive amount of time are purposely avoided.

Hydrocarbons

1. An equal intimate mixture of sodium acetate and soda lime, when heated in a test tube with jet outlet, will produce enough methane to be easily ignited.
2. Ethylene dibromide, ethanol and metallic zinc, when similarly heated will generate appreciable amounts of ethylene.
3. Amylene in carbon tetrachloride readily reacts with bromine. Amylene also similarly reacts with aqueous potassium permanganate.
4. Calcium carbide when added to water or ice generates sufficient acetylene to burn.
5. Acetylene forms a precipitate with ammoniacal cuprous chloride.

Alcohols

1. Most low molecular weight alcohols burn when ignited.
2. Water in ethanol may be detected by the addition of anhydrous copper sulfate or potassium permanganate.
3. Alcohols react with metallic sodium to form the alkoxides.
4. Ethanol and acetyl chloride readily form the ester.
5. Ethanol gives the iodoform test.
6. Glycerol can be dehydrated to acrolein by heat and $KHSO_4$.

Acids

1. Warm formic acid reduces ammoniacal silver nitrate with the formation of a silver mirror.
2. A warm mixture of formic and sulfuric acids liberates a sufficient amount of carbon monoxide to readily burn.
3. Many acid-alcohol combinations, when heated with sulfuric acid, produce pleasant smelling esters.
4. A number of simple qualitative tests for simple organic acids may be demonstrated.

Ethers, Esters and Anhydrides

1. The inflammability and explosive nature of diethyl ether can be easily demonstrated.

2. A few ml. of ether will dissolve in a larger volume of water, showing the limited solubility.

3. Low molecular weight esters will saponify with and dissolve in warm aqueous sodium hydroxide.

4. Acetic anhydride reacts with warm water or sodium hydroxide solution.

Aldehydes and Ketones

1. Aldehydes react with the familiar Schiff's, Fehling's, Tollen's, and Benedict's Reagents.

2. Many aldehydes and ketones form addition products with sodium acid sulfite at room temperature.

3. Acetone yields iodoform under the usual experimental conditions.

Amines and Amides

1. Amines dissolve readily in and react with common inorganic acids.

2. Acetamide reacts with nitrous acid.

3. Heated urea responds to the biuret test.

Halogen Compounds

1. Alcoholic methyl iodide reacts with alcoholic silver nitrate.

2. Organic halides produce a green flame when heated with copper wire.

3. Chloroform, aniline and potassium hydroxide produce the disagreeable odor of isocyanides.

4. Acetyl chloride reacts with water, alcohol and amines at room temperature.

Carbohydrates

1. Glucose, etc., reacts with Tollen's, Fehling's, Schiff's and similar reagents.

2. Several osazones can be prepared and their crystals shown with micro projection equipment.

3. The dehydration action of concentrated sulfuric acid on sucrose is spectacular.

4. The starch-iodine color is easily produced.

Proteins

1. Soluble proteins can be precipitated with heavy metal salts and alkaloids.

2. Soluble proteins respond to many familiar color reactions.

3. Wool cloth dissolves in warm sodium hydroxide solution.

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6. Hartung, E. J., *The Screen Projection of Chemical Experiments*, Cambridge University Press, New York, 1953.
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IMPORTANT CONFERENCE HELD AT CARNEGIE TECH

Dynamic response to shock and vibration caused by forces such as bomb blasts was the major theme at Carnegie Tech's 17th Research Conference, Friday, February 3.

The entire Department of Civil Engineering has been active in research projects aimed at testing materials and structures under dynamic forces and each member of the faculty addressed the business, industrial and government representatives attending the conference from all over the country.

Industrial groups, public agencies and individuals have contributed to support projects reported in the conference, among them the Rail Steel Bar Association, the Association of Iron and Steel Engineers, the Roll Manufacturers Institute and agencies of the U. S. Department of Defense.

The all-day program dealt with dynamic response of such materials and structures as reinforced concrete beams, titanium, iron work rolls, and floating structures.

Among events of the day was an actual test by Civil Engineering Head Dr. F. T. Mavis and graduate M. J. Greaves which measured and recorded the necessary volume of data during the short time interval of a blast. "Experiments like this have lagged behind field tests and mathematical analysis because the difficulty of measuring is enormous," according to Dr. Mavis. To close the gap he has linked a high-speed motion picture camera with cathode ray oscilloscopes to record some 2,500 essential measurements in less than one-tenth of a second, approximate time of an atomic blast.

Other speakers were Dr. E. D'Appolonia, R. G. Crum, Dr. C. F. Peck Jr., Dr. J. P. Romualdi, and Dr. T. E. Stelson.

The Carnegie Tech Research Conferences are part of the school's plan to serve industry with new basic knowledge through cross-fertilization of scientific adeas.

STEVE TURSHAN OF DETROIT HAS A PROBLEM

In the woods stands a dead tree which is hollow inside. At the top is a hole, also one at the bottom. The tree is 100 feet tall. Inside is a squirrel. First he runs to the top hole and sticks his head out; then he runs down to the bottom hole and does likewise. From the bottom to the top hole it took him 90 seconds; from the top to the bottom it took him 89 seconds. Each trip he goes a little faster so that he gains time.

Now then, what I'd like to know is, how fast will he have to be traveling before his head will be sticking out of ***both holes at the same time?***

THE ELEMENTARY SCHOOL SCIENCE LIBRARY FOR 1954–1955

PAUL E. KAMBLY AND EVELYN PIPER
School of Education, University of Oregon, Eugene, Oregon

This is the twelfth yearly list of reference books for elementary school science compiled and published in SCHOOL SCIENCE AND MATHEMATICS. The purpose, like that of preceding lists, is to suggest to elementary school teachers, books that are supplementary to basic text series either for their values as sources of information or for recreational reading. Certain books included primarily because of assumed value as recreational reading are below desired standards of good sources of science information. The sub-division topics are of no significance except as an aid in grouping the references.

The grade levels indicated are the lowest in which it is recommended that the books be used. Exact grade placement is difficult because of variations in pupil reading ability as well as differences in how the books are used. The recommendations and the brief annotations are based on an examination of each book listed.

REFERENCE BOOKS FOR ELEMENTARY SCHOOL SCIENCE[1]

Ancient Animals

	Grade	*Price*
Dinosaurs. By Marie Halun Block. 44 pp. '55. Coward-McCann. The story begins when the earth is about four billion years old. The animals living during the various prehistoric ages are named and there is a brief statement concerning their characteristics and habits in so far as science has been able to determine. Many children would enjoy this overview of early life on the earth.	4	$2.50
The Wonder World of Long Ago. By Marie Neurath. 36 pp. '55. Lothrop. Primarily a picture book which presents some information about many different forms of ancient life.	4	1.75
The Story of Our Ancestors. By May Edel. 199 pp. '55. Little, Brown. How man is believed to have developed. Some of the chapters are: Fossils are Clues, Our Primate Cousins, Neanderthal Man and Modern Man Arrives. There are a total of fourteen chapters. A book for good readers.	6	3.00

Animals

(See also list of books on birds and insects)

Monkeys. By Herbert S. Zim. 64 pp. '55. Morrow. Monkeys are entertaining and intriguing to most children and adults too. There are about 225 different kinds of monkeys. The living habits and characteristics of three groups of these monkeys, the Old World monkeys, New World monkeys and marmosets are described in a simple concise way. The respon-	2	2.00

[1] Publishers and their addresses are listed at the end of this section.

	Grade	Price
sibility of having a monkey as a pet is explained to children in such a way that they may realize the time and continuous effort that is necessary to keep a monkey as a pet.		
Seals and Walruses. By Louis Darling. 63 pp. '55. Morrow.... The place of seals and walruses in the order of mammals is developed through the story and illustrations. Many children will be interested in the traits and the detailed description of the habits of the fur seals who return to the same location on the Pribilof, Commander and Robben Islands to breed and to bear their young. The sea lions living off the coast of California and Mexico become the circus performers. The characteristics of these animals are described as well as those of the harp seal, ribbon seal, and others.	2	2.00
The Wonder World of the Seashore. By Marie Neurath. 36 pp. '55. Lothrop.......... The unusual characteristics and habits of some of the strange and fascinating sea animals such as the jelly fish which develops from a formation that resembles a stack of saucers, the star fish which can replace points that are lost by growing new ones and the hermit crab who often teams up with a sea anemone to gain a living. Reading is kept to a minimum, the illustrations are used to enlarge and clarify the information.	2	1.75
Beasts of Burden. By Mina L. Simon. 87 pp. '54. Lothrop..... An attrative book which tells about the oxen, carabao, burro, Eskimo dog, reindeer, horse, camel, llama, Shetland pony, elephant and yak.	3	2.50
The Big Cats. By Herbert S. Zim. 64 pp. '55. Morrow......... This "information packed" book gives the distinguishing characteristics of the main species of the big cat family including lions, cougars, leopards, cheetahs, ocelots, tigers and jaguars. The particular features which contribute to the big cats' success in hunting are analyzed. The most dangerous cat, the tiger, kills over a thousand people each year.	3	2.00
Gray Squirrel. By Mary Adrian. 46 pp. '55. Holiday.......... The yearly events of a gray squirrel's life well written and illustrated. The story includes an account of the migration of a large group of gray squirrels and describes what happens to to decrease their number during the migration.	3	2.00
The Octopus. By Olive L. Earle. 64 pp. '55. Morrow.......... Includes detailed information which should help to satisfy the avid curiosity of children concerning several creatures of the sea; squid, cuttlefish, chambered nautilus, argonaut, spirula as well as the octopus. Both the physical appearance and the habits of living are explained through the text and the illustrations.	3	2.00
Animal Clothing. By George F. Mason. 91 pp. '55. Morrow...... For children who are interested in animals, this book should provide both interesting and unusual information. The different kinds of hair, feathers, skin, shells, and scales are described and the functions are explained such as the armadillo's suit of mail is described as resembling the trappings worn by Roman gladiators.	4	2.00
Animal Masquerade. By Ivah Green. 64 pp. '55. Coward-McCann.......... Full-page photographs on every other page show the animals and the text describes how the "masquerade" features are of value to the animals. An excellent reference on adaptations.	4	2.50

Grade *Price*

Here Come the Elephants. By Alice E. Goudey. 93 pp. '55. Scribners 4 2.25
There are two life stories, first of African elephants and then Asian elephants. Both are very interesting and there are many facts about elephants. The description of the method of catching and training an Indian elephant should be of great interest to many children.

How the Animals Eat. By Millicent Selsam. 91 pp. '55. William R. Scott 4 2.50
Every animal must eat to live and animals vary greatly in their methods of obtaining food. There are three main sections called Dinner in the Water, Dinner on Land, and Dinner in the Air. The last section is an excellent introduction to food chains.

Wonders of the Wild. By Jacquelyn Berrill. 85 pp. '55. Dodd... 5 2.50
The homes, defense, language, social groups and play of animals are described in a general way in the first six chapters. The last four chapters are about the animals of tropical Africa, Asia, South America and North America. There are numerous drawings of animals described in the text.

The Fearless Family. By Gardell Dano Christensen. 160 pp. '55. Holt 6 2.75
Stories about the lives and habits of animals such as weasels, martens, minks, otters, skunks, badgers and wolverines. All belong to the same family which the author calls "Fearless."

Astronomy

The Golden Book of Astronomy. By Rose Wyler and Gerald Ames. 97 pp. '55. Simon 5 5.00
In the foreword Bart J. Bok, Professor of Astronomy at Harvard University, says, "This is a book young readers should read and re-read, studying each page and illustration with care and weighing each sentence and paragraph. For many this book may mark the beginning of a lifelong interest."

Birds

Chickens and How to Raise Them. By Louis Darling. 63 pp. '55. Morrow 2 2.00
Raising chickens can be a very profitable and interesting hobby. There are many opportunities in raising chickens to increase scientific understanding. The entire hobby of chicken raising is developed from the standpoint of choice of breeds, housing and feeding. The growth of the chicken is described, from the fertilized ovum to the moment the chick breaks through the egg by using his egg tooth.

What's Inside? By May Garelick. 64 pp. '55. William R. Scott. 2 2.00
Primarily a book of excellent photographs by Rena Jakobsen showing a gosling emerging from an egg and later exploring its new world. The short informative text is written in such a a way as to encourage participation by young readers.

Barn Swallow. By Paul McCutcheon Sears. 45 pp. '55. Holiday 3 2.00
An interesting story of a year in a barn swallow's life, from his first flight in the Mississippi valley, through his migration to South America and back, to the selection of his mate and the building of a nest back in the valley.

	Grade	Price
The Swans of Willow Pond. By Olive L. Earle. 64 pp. '55. Morrow	3	2.00
The story of a swan family during one year. Good large drawings help to make the book interesting and attractive.		
Vulcan—The Story of a Bald Eagle. By Robert M. McClung. 64 pp. '55. Morrow	3	2.00
The story begins as Vulcan is hatched from an egg in a nest high in the crown of an ancient white pine tree. He learns the ways of his bald eagle family. He learns to fly, plunge for fish and other food, and to migrate south for the winter. He escapes a number of dangers including a hunter who kills his mate. He is finally caught in a trap but is later set free by the little boy and his father who had set the trap.		

Conservation

	Grade	Price
Lookout for the Forest. By Glenn O. Blough. 48 pp. '55. Whittlesey	4	2.25
A conservation book. Animals in the forest, forest farmers, lookout towers, insects, fires and fire-fighting are all included in this well-written and excellently illustrated book.		
Fish and Wildlife. By C. B. Colby. 48 pp. '55. Coward-McCann	5	1.25
The story of the United States Fish and Wildlife Service. Many large photographs show the types of activities carried on.		
Park Ranger. By C. B. Colby. 48 pp. '55. Coward-McCann	5	1.25
The work and equipment of the National Park Rangers shown by excellent photographs of various scenes taken in national parks.		
Tall Timber. By C. B. Colby. 48 pp. '55. Coward-McCann	5	1.25
The work of the United States Forest Service presented with excellent photographs and text. Emphasizes the recreational value of forest lands.		

General Nature Study

	Grade	Price
In Ponds and Streams. By Margaret Waring Buck. 72 pp. '55. Abingdon	4	3.00
An encyclopedia type of book of illustrations and descriptions of flowers, ferns and rushes, insects, fishes, snails, snakes, toads, frogs, turtles, birds and small mammals that are found in and around ponds and streams.		
The American Southwest. By Natt N. Dodge and Herbert S. Zim. 160 pp. '55. Simon	5	1.95
Presents facts on natural wonders together with animals, plants and minerals in full color. One of the Golden Nature Guides. Other books in the series are titled Birds, Flowers, Insects, Mammals, Reptiles and Amphibians, Seashores, Stars, and Trees.		
The Pond Book. By Albro Gaul. 136 pp. '55. Coward-McCann	5	2.75
A story of living things in and around a pond beginning in the spring and ending when the pond freezes in winter. The last two chapers are called, "The Life Story of a Pond" and "Useful Ponds." The excellent photographs by the author were taken at his own pond in western Massachusetts.		
Seashores. A Guide to Animals and Plants Along the Beaches. By Herbert S. Zim and Lester Ingle. 160 pp. '55. Simon	5	1.95
An excellent pocket size source book of the seashore. The tides, waves, and irregularities of the American coast are pictured		

	Grade	Price
and explained. A family tree of sea animals is shown. There are 475 shells, sea plants, and shore birds shown in full color and described in a few sentences.		
Outdoor Hazards. Real and Fancied. By Mary V. Hood. 242 pp. '55. Macmillan	6	3.95
Mammals, birds, reptiles, fish and other sea dwellers, insects and their relatives, poisonous and irritating plants are all included. The last section discusses a number of hazards of the camp and trail. The small print may discourage all but the best readers.		
World Outside My Door. By Olive Bown Goin. 184 pp. '55. Macmillan	6	3.50
A Florida housewife naturalist explores the living wilderness in her own back yard. The activities of a variety of amphibians, reptiles, birds, mammals, and a few invertebrates are described.		

General Science

	Grade	Price
Now I Know. By Julius Schwartz. 32 pp. '55. Whittlesey	1	2.00
A simple science picture book in which a small child explains such things as the reflection in the window, where the rain goes and the sounds he hears. He makes a small electric storm himself and experiments with shadows. It should help children to become more observant and to explain some of the sounds, sights and feelings which they may not understand or which they may fear.		
Speeding Into Space. By Marie Neurath. 36 pp. '54. Lothrop	1	1.75
Most children are intensely interested in space travel; the book should help to answer some of their vital questions. It poses the problems to the young reader that scientists are encountering to make space travel possible. It suggests ways in which the scientists are attempting to overcome these difficulties. Both the illustrations and text are simple, direct and forceful.		
Pogo's Oil Well. By Ernest Norling. 56 pp. '55. Holt	3	1.75
John and his dog, Pogo make a trip with father to see and learn about the old fields and the refinery. As John and Pogo watch, father and the workmen explain the drilling and also the processing of the crude oil to produce gasoline, kerosene and the many other products. The illustrations make a real contribution in helping to make the oil fields and the refinery more real to children.		
Who Fishes for Oil. By Norman Bate. 44 pp. '55. Scribners	3	2.50
A small fishing boat becomes tired of his work with "messy fish." His opportunity comes to save some workmen from an oil drilling platform during a hurricane. Because of his assistance during the storm, he is asked to carry "things" to the drilling barge. After the oil well gushes oil over his decks and windows he decides to return to his fishing business. In spite of talking boats and machines this has some value as a reference book.		
Around the World in a Flash. By Marie Neurath. 36 pp. '54. Lothrop	4	2.10
An elementary explanation of how messages are sent by telephone, telegraph, radio and television. The illustrations help to make the book understandable to children.		

	Grade	Price
The Magic of Water. By G. Warren Schloat, Jr. 50 pp. '55. Scribners . . . . Many photographs and drawings are used to supplement the text which tells what water does for people and other living things. There are a few experiments with evaporation and condensation of water and solutions. Pictures and text also provide information concerning the amount of water used by various living things.	4	2.50
Fire in Your Life. By Irving Adler. 128 pp. '55. Day . . . . The chapter titles are "Man finds fire; What is fire; Learning to make fire; Fire, comfort, freedom; Fire, the magician; Fire and power; Fire and destruction; Fuels and the future. There are many interesting facts about smelting and engines that will be interesting especially to upper grade boys.	5	2.75
Atoms, Today and Tomorrow. By Margaret O. Hyde. 140 pp. '55. Whittlesey . . . . An elementary explanation of atomic energy that will be interesting to children and to adults having a limited science background. The present uses and the future potential of atomic energy for transportation, medicine, agriculture and industry are explained. Cartoon like illustrations are included.	6	2.50
Diving for Science. By Lynn Poole. 160 pp. '55. Whittlesey . . . . Discusses findings in the fields of underwater mineral and oil deposits, exploration of sea caves, charting of fish migration and fish feeding, and salvage of sunken treasure. The author is the producer of the ***Johns Hopkins Science Review.***	6	2.75
Time in Your Life. By Irving Adler. 128 pp. '55. Day . . . . Time is interpreted through the many rhythms that surround us including the rhythms in rocks and the rhythm in space. Children should develop an understanding or a feeling of the history of the ages as they read the book. There is a description of the way people have tried to measure time including moon calendars, sun calendars, water clocks and others.	6	2.75
Where Speed Is King. By Margaret and Edwin Hyde. 144 pp. '55. Whittlesey . . . . Track events, sailing, skating, bicycles, pigeon racing, horse racing, and many other sports. Information about people and records as well as about safety, health and sportsmanship.	6	2.50

Insects

Insect Friends. By Edwin Way Teale. 96 pp. '55. Dodd . . . . The illustrations are the outstanding feature of this book about twenty-seven different insect friends. Even those children who are unable to read the text will be fascinated by the photographs. Those who can read will also enjoy the excellent information given.	4	3.00

Physiology

Laugh and Cry. By Jerrold Beim. 47 pp. '55. Morrow . . . . The explanation of emotions on the children's level should be very helpful in assisting them to understand and accept themselves. The fact is emphasized that feelings of anger, fear, love, sorrow and joy are typical of adults as well as children. Ways to divert harmful emotions into constructive channels are explained in an easy relaxed manner. This is a vital subject to	3	2.00

	Grade	Price
all people including children. It is handled in a simple matter-of-fact way.		
The Wonders Inside You. By Margaret Cosgrove. 84 pp. '55. Dodd	5	2.50
The first chapter compares the human body to a city and the rest of the chapters bear out the comparison. Sample chapter titles are "The Pumping Station," "The Fuel," "The Plumbing Department," and "The Government of the City." The author is a medical artist and she has illustrated this book with many line drawings.		
Our Wonderful Eyes. By John Perry. 158 pp. '55. Whittlesey	6	2.75
An excellent reference book for the study of light as well as the human eye. Line drawings by Jeanne Bendick help to develop the text but only good readers can be expected to use the book.		

Plants

	Grade	Price
The Flower. By Mary Louise Downer. 32 pp. '55. William R. Scott	2	1.75
A simply told story of the germination of a seed and the growth of a plant. Large illustrations supplement the text.		
Gifts From the Grove. By Gertrude Wallace Wall. 96 pp. '55. Scribners	3	2.50
A factual story of the history and of the processing of citrus fruit. The cultivation of the crops, the work of the weather bureau, the control of temperature, the transportation and the processing of the fruit is described in a simple direct way. Photographs are used effectively.		
What Tree Is It? By Anna Pistorius. 28 pp. '55. Follett	4	1.50
A typical beginners book on tree identification except for some unique questions such as: What tree grows witches brooms? What tree was dog medicine? What tree has honey in its leaves? What tree is the beaver's favorite food? What tree is for baseball bats? What tree resists lightning? The names of the trees are not given in the text but are listed by number in the back of the book.		
The Plants We Eat. By Millicent E. Selsam. 125 pp. '55. Morrow	6	2.50
Human life depends on the roots, stems, leaves, flowers, fruits and cereal grains we eat. Line drawings help to clarify the text.		

Transportation

	Grade	Price
The First Book of Automobiles. By Jeanne Bendick. 64 pp. '55. Watts	4	1.95
Different kinds of cars and trucks and how they work. A little about the first automobiles and some discussion of how cars have changed America. Illustrated by the author.		
Pogo's Truck Ride. By Jo and Ernest Norling. 46 pp. '54. Holt	4	1.75
As a birthday present John and Pogo are allowed to go on a trip in a trailer truck. A story of motor freight as well as lessons in good driving.		
Earthmovers. By C. B. Colby. 48 pp. '55. Coward-McCann	5	1.25
Excellent pictures and descriptions of the heavy duty trucks and other machines used in earth moving operations.		

Publishers and Their Addresses

Abingdon: Abingdon-Cokesbury Press, 810 Broadway, Nashville 2, Tennessee.

Coward-McCann: The John Day Company, 121 Sixth Avenue, New York 13, New York.
Day: The John Day Company, 121 Sixth Avenue, New York 13, New York.
Dodd: Dodd, Mead and Company, Inc., 432 Fourth Avenue, New York 16, New York.
Follett: Wilcox and Follett, 1255 South Wabash Avenue, Chicago 5, Illinois.
Holiday: Holiday House, 8 West Thirteenth Street, New York 11, New York.
Holt: Henry Holt and Company, Inc., 383 Madison Avenue, New York 17, New York.
Little, Brown: Little, Brown and Company, 34 Beacon Street, Boston 6, Massachusetts.
Lothrop: Lothrop, Lee and Shepard Co., Inc., 419 Fourth Avenue, New York 16, New York.
Macmillan: The Macmillan Company, 60 Fifth Avenue, New York 11, New York.
Morrow: William Morrow and Company, 425 Fourth Avenue, New York 16, New York.
William R. Scott: William R. Scott, Inc., 8 West Thirteenth Street, New York 11, New York.
Scribners: Charles Scribner's Sons, 597 Fifth Avenue, New York 17, New York.
Simon: Simon and Schuster, Inc., 630 Fifth Avenue, New York 20, New York.
Watts: Franklin Watts, Inc., 119 West Fifty-seventh Street, New York 19, New York.
Whittlesey: McGraw-Hill Company, 330 West Forty-second Street, New York 18, New York.

AWARDS FOR GOOD TEACHING

Four outstanding educators at Carnegie Institute of Technology have been chosen to receive the Carnegie Teaching Awards, Carnegie Tech President, Dr. J. C. Warner, announced today.

The teaching awards were initiated in 1952 under a grant from the Carnegie Corporation of New York to stimulate good teaching in Carnegie's unique plan of professional education.

"Each year," President Warner explained, "awards are given to the four teachers who are most outstanding as measured by Carnegie's educational objectives, and in their influence upon the teaching of others."

Recipients of this year's Carnegie Teaching Awards are Lawrence N. Canjar, Associate Professor of Chemical Engineering, Hugo A. Meier, Assistant Professor of History, Robert M. Morgan, Associate Professor of Psychology and Education, and Erwin R. Steinberg, Associate Professor of English.

The awards are equal to half the teacher's annual salary. They will provide either two summers or one semester of freedom from academic duties at the Institution. The recipient can use his award to rest, study, travel or do whatever he decides would be of most value to him.

Candidates for the awards are recommended by the Deans of the Institution and the winners are selected by special committees. This year's committee consisted of Winton Tolles, Dean of Hamilton College, Charles B. Nutting, Acting Chancellor of the University of Pittsburgh, Carnegie President J. C. Warner, and Provost Elliott Dunlap Smith, and Mr. Walter J. Blenko, Chairman of the Executive Committee of the Carnegie Tech Board of Trustees.

Lightweight Scaffolding for building is rated at 50 pounds per square foot. A section of scaffold four feet high by four feet wide by seven feet long has only four parts. Both frames and braces are made of high carbon steel tubing.

AN EASY DOES IT

TRANSFORMATIONS OF ENERGY

REBECCA E. ANDREWS
Woodrow Wilson High School, Washington 16, D. C.

Not the construction of a new piece of apparatus is described here but simply a recombination of old pieces of apparatus. Most physics teachers and perhaps general science teachers have three inclined planes, one Hall's carriage, and two rods with supports.

The arrangement is shown in Figure 1. Two inclined planes, *C* and *D*, are elevated so that they make the same angle with the table and inclined plane *E* is placed flat on the table with its width between them. Car *F* is started at an observed height on *C* and in the middle of the width of the plane. The car rolls down *C*, across *E*, and up *D* but never to as great a height on *D* as that at which it started on *C*. It should also be started on *D* and allowed to roll in the opposite direction.

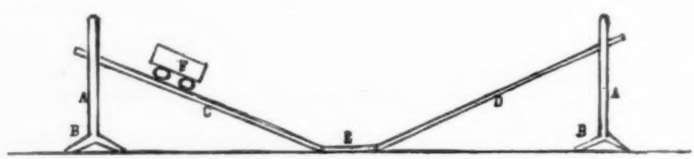


FIG. 1. Transformations of energy.

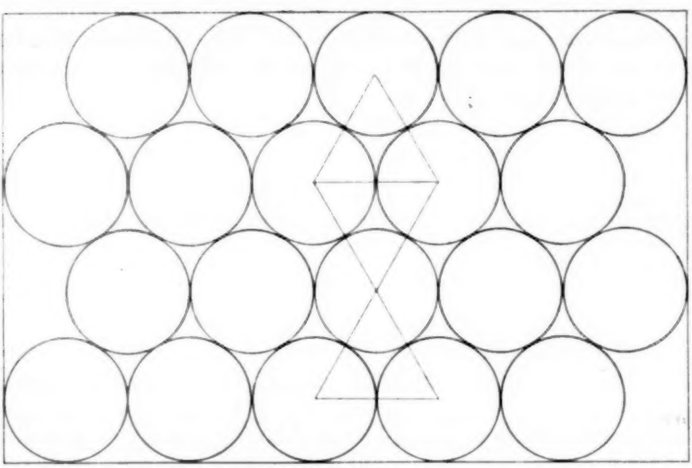
This demonstration has an advantage or two. It may supplement the more traditional demonstration of the vibrating pendulum on which many teachers depend for the illustration of transformations of energy. It may perhaps provide a more realistic touch than the pendulum in that pupils may be more interested in coasting sleds and wagons and cars, which is suggested by this demonstration, than in accurately timed chronometers, which is suggested by the pendulum.

If the pupils have already thought of potential and kinetic energy, they can readily see that the car has potential energy when it is located up the incline, that it gains kinetic energy with a loss to potential as it rolls down the incline, and that it regains potential with a loss to kinetic as it rolls up the incline. They also begin wondering about the reason for the failure of the car to return to as great a height on *D* as its original height on *C* and the nature of friction arises in their minds. In this way the demonstration is used to illustrate transformations of energy.

THE MOST ECONOMICAL TIN CAN

R. F. GRAESSER
University of Arizona, Tucson, Arizona

A perennial problem occurring in nearly every calculus textbook is that of finding the proportions of a tin can with a cover which will require a minimum amount of tin, the can being in the form of a right circular cylinder. The answer to this problem is that the height must equal the diameter making a rather low can. A distinguished mathematician once remarked that the tall cans in the grocery stores were monuments to the little girls who would not study mathematics. But does the above solution give the most economical dimensions for a can when we consider the waste of tin necessary in



cutting out the circular top and bottom? To investigate this question, first assume that there is no waste in cutting the side of the can. Then let r be radius of the top and bottom. If a times b circles of radius r are arranged as in the figure, a circles in a row with b rows, and then enclosed in a rectangle of tin, the area of tin needed per circle is the area of the rectangle divided by the number of circles, or

$$r\{(b-1)\sqrt{3}+2\}r\{2a+1\}/ab=r^2M,$$

where

$$M=\{(b-1)\sqrt{3}+2\}\{2a+1\}/ab=2\sqrt{3}+\frac{2(2-\sqrt{3})}{b}+\frac{\sqrt{3}}{a}+\frac{2-\sqrt{3}}{ab}\cdot(1)$$

This is assuming an ideal situation in which the rectangles of tin available exactly correspond to certain values of a and b. Let A be the area of the tin needed to make a can, V the volume of the can, h its altitude, and r its radius. Then $A=2\pi rh+2r^2M$, and $V=\pi r^2h$. Hence $A=2Vr^{-1}+2r^2M$. The ratio of h to $2r$ which minimizes A is readily found to be M/π. From (1) it is seen that M decreases as a and b increase, and the minimum value of M is $2\sqrt{3}$. Hence $h/2r \geqq 2\sqrt{3}/\pi = 1.103^-$. On the other hand, it would seem that a reasonable maximum amount of waste would occur if each circle were cut from a circumscribed square. Here again we might assume the ideal situation that the rectangles of tin available have dimensions which are multiples of $2r$. Then $A=2\pi r^2h+8r^2$, and $V=\pi r^2h$. Hence $A=2Vr^{-1}+8r^2$. The ratio of h to $2r$ which now minimizes A is readily found to be $4/\pi=1.273^+$. Hence $1.103^- \leqq h/2r \leqq 1.273^+$.

To test this result, approximate measurements were made upon some standard size tin cans, and the ratio $h/2r$, or altitude/diameter, was computed. The results appear in the table. Perhaps deviations above our upper limit might be due to the unavailability of the assumed sizes of rectangles of tin.

Can Number		1	$1\frac{1}{2}$	2	$2\frac{1}{2}$
Weight ozs.	8	11	16	20	28
Altitude mm.	75	100	110	114	118
Diameter mm.	66	67	80	85	101
Altitude/Diameter	1.14	1.49	1.37	1.34	1.17

EUROPEAN STUDY TOUR IN COMPARATIVE EDUCATION

Wayne University's College of Education again approves credit for the European Study Tour in Comparative Education. Personally conducted by Professor Wm. Reitz, this ninth annual tour will leave Detroit on June 19, 1956 and return September 2, 1956. Qualified persons may earn up to eight hours of graduate or undergraduate credit.

The tour is designed for students, teachers, and professional people interested in the life and culture of Europe. It offers opportunity to survey Europe's educational, social, and civic institutions; confer with the leaders; visit schools and universities; talk with the people; view Europe's famous landmarks such as cathedrals, castles, art galleries; enjoy Europe's gaieties such as plays, operas, and festivals; and absorb the atmosphere of old world cities.

Further details and information may be obtained from Dr. Wm. Reitz, College of Education, Wayne University, Detroit, Michigan.

Snake Bite Kit is lightweight and re-usable. Molded from nylon resin, it is designed for emergency use. The pocket-sized kit contains a tourniquet, lancet, suction pump, antiseptic and ammonia inhalant.

ROOM ENOUGH FOR YOU?

WILLIAM R. RANSOM
Tufts College, Mass.

The following calculation was offered to someone who expressed his disbelief in the after-death survival of human souls, on the ground that there would nowhere be room for so many.

Suppose that ample accommodation for any one would be a house on a lot with 100 feet frontage, 200 feet in depth, with 500 feet head room: that would make 10^4 cubic feet for each. Now, how many must be provided for?

From 8,000 B.C. to 2,000 A.D., 10^7 years, there are about 300 generations, but suppose we go farther back and allow for 10,000 generations.

The world now contains two and a half billion people. In the days preceding our known civilizations, it has been estimated, that there may not have been above three million. But suppose we make a super-generous estimate: that in the 10^4 generations the population

grew from ten million, 10^7, to ten billion, 10^{10}. The total number in this estimate would be the sum of a geometrical progression of 10^4 terms, beginning with 10^7, and ending with 10^{10}. The ratio in this progression would be the ten-thousandth root of one thousand, which comes out to be about 1.0001, or $(1+10^{-4})$. By means of this we find that the sum of the progression is $10^{10}\div 10^{-4}=10^{14}$. For each of these we have proposed to set aside 10^4 cubic feet, a total of 10^{18} cubic feet. Where can we find room?

Many parts of the universe might be visited in the hunt, but an easily identified locale is the bowl of the Big Dipper. This bowl is 5° deep and 10° across.

The pointers are over 100 light years away, and at this distance 5° implies a distance between them, h feet, of about 10 light years,

$$10\times 186{,}000\times 60^2\times 24\times 365\times 5280 \text{ feet}$$

or $h=3\times 10^{17}$. Into the bowl we could put a cylinder, altitude and radius both equal to h, and its volume would be $\pi h^3=9\times 10^{52}$ cubic feet.

This provides ample room for the 10^{14} souls, for whom we have reserved 10^{21} cubic feet. In fact, each of them has room to extend his spatial accommodation to $9\times10^{52}\div10^{21}=9\times10^{31}$ times as much as we allowed: that is, there is room for ninety thousand billion billion billion times as much room in the bowl of the dipper alone!

A COMMISSION TO INVESTIGATE MATHEMATICS

A Commission on Mathematics that will investigate the need for revision of the secondary school mathematics curriculum has been appointed by the College Entrance Examination Board.

New frontiers in mathematics are creating almost unlimited opportunities for growth in mathematical knowledge and its applications to physical science and engineering, to the social and biological sciences, and to business and industry. The Commission has been established by the College Board in recognition of a growing divergence between these developments and the type of mathematics taught in secondary school.

For over 50 years, high school mathematics for college preparatory students has remained essentially unchanged—the traditional presentation of algebra, geometry, and trigonometry. Much readjustment of teaching methods and topical emphasis has of course occurred, partially under the impetus of recommendations of such able groups as the 1923 Committee on Mathematical Requirements.

Meanwhile, the very nature of mathematics has changed radically to a form now vaguely referred to as modern mathematics. After stressing modern mathematical concepts only in graduate courses for many years, many college mathematics departments are readjusting freshman courses to include these ideas. No equivalent trend has yet developed widely on the high school level.

The Commission on Mathematics, a group of 13 high school and college mathematics teachers, proposes to investigate the need and possibilities for revision of the high school syllabus. Its charge is broad in scope. One or more conferences of high school and college teachers and administrators will be summoned to advise and assist the Commission. Following such meetings, and in the light of the experience and deliberations of its own members, the Commission will recommend necessary and desirable action to the College Board.

Curricular reform has often failed to result from the work of previous conferences and commissions in mathematical education because their recommendations have been only partially implemented. In view of this, the College Board is prepared to take further action. If there is general agreement as to the need and form of curricular revision, the College Board will, if necessary, foster the development of teaching materials and workshops to prepare teachers to utilize these materials.

With this charge at hand, the Commission met for the first time at Ann Arbor, Michigan, in August 1955, and reached the following tentative conclusions:

(1) High school mathematics is in need of revision which would include the addition of new materials and the elimination of some and reorganization of other topics now being taught;

(2) In considering a topic for deletion or inclusion the Commission will bear in mind the relevance of the topic to modern mathematics, social and natural science, and engineering;

(3) Liaison with and the cooperation of all groups interested in school and mathematics curricula is essential;

(4) The development of a single definitive syllabus is undesirable, if not impossible. The Commission therefore proposes to formulate a broad list of topics and to suggest where and how they might be introduced.

CONCERNING THE SAND AT THE SEASHORE

Julius Sumner Miller
El Camino College, El Camino College, California

What I report here may be common experience but the physics involved is somewhat obscure.

The sand at the seashore exists in what we might call (with license!) three "phases." There is the *dry* sand, that which is much beyond the water's reach; the *wetted* sand over which the tide washes and from which it then recedes; the *wet* sand which is always completely submerged and which is never free of the ocean water above it. My inquiry concerns the forces at play which give to each of these "phases" the striking characteristic which it possesses.

The *dry* sand, high on the beach, possesses little or no solidity. One can move it about with ease or dig a toe into it. Friction forces between the particles are negligibly small. A hole now dug promptly fills or caves in. Since the particles are rounded by the rolling motion they have undergone for centuries they roll over each other with great freedom.

The *wetted* sand is astonishingly rigid, which is to say that the friction forces are clearly enormous. The assemblage of particles acts like a rigid body. One can walk or ride on this section of the shore with great ease and little impression is made. The surface is hard. Now what mechanism prevails in this state or phase? I suppose we should say that the water between the grains of sand *pulls* the grains together by capillary action, which is equivalent to increasing the friction forces between adjacent particles. Or, because of surface tension effects between adjacent particles they are difficult to dislodge, one from another, since work would need to be done to increase the surface (tension) energy. All this appears logical.

Now what characterizes the *wet* sand *beneath* the water? Quite astonishingly, it, too, is highly penetrable. Coupling the analysis above with the fact that the hydrostatic pressure upon these submerged particles should pack them more closely and hence increase the friction forces, we should expect the submerged sand to be *less* penetrable. *What goes on here?* Are the submerged particles buoyed up by Archimedes' forces so that they are *less* closely packed?

Trap-Shooting Set contains five targets and a target slinger. The targets are made of a porous, cellular material painted bright orange and measures four and three-quarters inches in diameter and one-half inch thick. Target slinger has a 15-inch handle. The target flutters and even changes course. This set is useful for practice shooting almost anywhere and at any time of year.

PROBLEM DEPARTMENT

CONDUCTED BY MARGARET F. WILLERDING
Harris Teachers College, St. Louis, Missouri

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the Department desires to serve his readers by making it interesting and helpful to them. Address suggestions and problems to Margaret F. Willerding, Harris Teachers College, St. Louis, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Solutions should be in typed form, double spaced.

2. Drawings in India ink should be on a separate page from the solution.

3. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

4. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

2463, 2465, 2469. *Walter R. Warne, St. Petersburg, Fla.*

2469. *Timothy McGrath, Harper's Ferry, Va.*

2469. *Mary E. Donica, Brooklyn, N. Y.*

2485, 2486. *A. R. Haynes, Tacoma, Wash.*

2485. *Millard Agerton, Preston, Ga.*

2489. *Paul Renton, Westbrook, Conn.*

2491. *Proposed by Brother Felix John, Philadelphia, Pa.*

Show that a, m_c, and b of triangle ABC cannot form an arithmetic progression.

Solution by Charles H. Butler, Kalamazoo, Mich.

(Note: this proposition is valid only for cases in which a, m_c, and b are taken in that order, or in which they are taken in the order m_c, a, b with $a=b$ or $a=m_c$. It does not hold in cases where $m_c<a<b$. The problem of proving this will be proposed in a later issue of this JOURNAL. Proofs are given below for the cases in which the proposition as stated does hold.)

Let us arbitrarily consider $a\leq b$. As a preliminary step let us recall the theroem that the median drawn from any vertex of any triangle to the opposite side is less than half the sum of the two sides meeting at that vertex. This theorem is easily established, but to save space the proof will be omitted here. It can be found in Taylor and Bartoo *College Geometry* (Macmillan, 1949, p. 48). From this theorem we have at once the relation $2m_c<a+b$. Let us call this Theorem I. It is perfectly general.

Now if a, m_c, and b, *taken in that order*, should form an arithmetic progression, then we would have $m_c-a=b-m_c$, or $2m_c=a+b$. But this is impossible because

by Theorem I (above) we know that $2m_c < a+b$. Hence a, m_c, b, taken in that order, can never be in arithmetic progression. It remains then to consider them in the only other possible order: namely, in the order m_c, a, b. There are two possible cases: namely, where $a=b$ and where $a=m_c$.

Let us examine first the case where $a=b$. The triangle in this case will be isosceles and m_c will be less than either a or b. But now it is readily seen that m_c, a, b cannot be in arithmetic progression in that order because $a-m_c>0$ while $b-a=0$. Since there are no other alternatives, the proposition is established for the case where $a=b$.

Finally, consider the case where $m_c=a$. Now since $a<b$, it follows that $b-a>0$ while $a-m_c=0$. Hence m_c, a, b cannot be in arithmetic progression in that order when $m_c=a$.

Thus the proposition has been established for all cases except the case in which $m_c<a<b$. It does not hold true in this latter case.

Solutions were also offered by Rebecca Johnson, Aurora, N. Y.; J. W. Lindsey, Amarillo, Texas; David Rappaport, Chicago, Ill.; Peter Van Vleet, Ovid, N. Y.; and Walter Warne, St. Petersburg, Fla.

2492. *Proposed by Hugo Brandt, Chicago, Ill.*

In a parabola $y^2=2px$, if $P_0P_1P_2$ are three points of it so that chords P_0P_2 and P_1P_2 are normal to the curve at P_0 and P_1 respectively, show that

$$x_0x_2=(x_0+p)^2$$

$$x_1x_2=(x_1+P)^2$$

$$x_0x_1=p^2.$$

Solution by C. N. Mills, Sioux Falls, S. D.

The slope of the normal at P_1 is $-y_1/p$, and the slope of the normal at P_0 is $-y_0/p$. Also $y_0^2=2px_0$, $y_1^2=2px_1$, and $y_2^2=2px_2$. Hence,

$$\frac{y_2-y_1}{x_2-x_1}=\frac{2p}{y_2+y_1}=-\frac{y_1}{p} \tag{1}$$

$$\frac{y_2-y_0}{x_2-x_0}=\frac{2p}{y_2+y_0}=-\frac{y_0}{p} \tag{2}$$

Dividing equation (1) by equation (2) gives

$$\frac{y_2+y}{y_2+y_1}=\frac{y_1}{y_0}.$$

Applying a principle of proportion, gives

$$\frac{1}{y_2-y_1}=-\frac{1}{y_0}.$$

Hence $y_0+y_1+y_2=0$, or

$$\sqrt{x_0}+\sqrt{x_1}+\sqrt{x_2}=0. \tag{3}$$

The equation of the normal at P_1 is

$$y-y_1=-(y_1/p)(x-x_1). \tag{4}$$

The equation of the normal at P_0 is

$$y-y_0=-(y_0/p)(x-x_0). \tag{5}$$

These two normals intersect at P_2. Solving equations (4) and (5), gives

$$x_2=x=p+x_1+\sqrt{x_0x_1}+x_0.$$

Hence

$$x_0+2\sqrt{x_0x_1}+x_1=p+x_1+\sqrt{x_0x_1}+x_0,$$

from which we get

$$\sqrt{x_0x_1}=p, \quad \text{or} \quad x_0x_1=p^2.$$

$$x_0x_2=px_0+\sqrt{x_0x_1}+x_0\sqrt{x_0x_1}+x_0^2,$$

hence

$$x_0x_2=(x_0+p)^2$$

$$x_1x_2=px_1+x_1^2+x_1\sqrt{x_0x_1}+x_0x_1,$$

hence

$$x_1x_2=(x_1+p)^2.$$

Comment. The condition (3) might be obtained by using the fact that the equation for any normal in terms of its slope is a cubic in which the second degree term coefficient is zero. Then the sum of the three slopes equals zero.

Solutions were also offered by **A. R.** Haynes, Tacoma, Wash. and the proposer.

Editor's Note. C. N. Mills is an Ex-Editor of the Problem Department of SCHOOL SCIENCE AND MATHEMATICS.

2493. *Proposed by Willis B. Porter, New Iberia, La.*

If a and b are real integers, express $N=(re^{\theta i})^{a+bi}$ in the form $A+Bi$, where A and B are real numbers.

Solution by James Dowdy, San Antonio, Tex.

We take the logarithm of N. For notation let $\log_e v=\ln v$.
Therefore,

$$\begin{aligned}\ln N&=(a+bi)\ln re^{\theta i}\\&=(a+bi(\ln r+\ln e^{\theta i})\\&=(a+bi)(\ln r+\theta i).\end{aligned}$$

Therefore,

$$\begin{aligned}N&=e^{(a+bi)(\ln r+\theta i)}\\&=e^{a\ln r+bi\ln r+a\theta i-b\theta}\\&=e^{A'+B'i},\end{aligned}$$

where

$$A'=a'\ln r-b\theta$$

and

$$B'=b\ln r+a\theta$$

But from Euler's relation:

$$e^{B'i}=\cos B'+i\sin B'.$$

Therefore,

$$N=e^{A'}(\cos B'+i\sin B').$$

That is,

$$N=A+Bi,$$

where

$$A=e^{A'}\cos B'$$

and

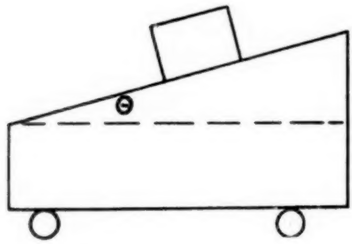
$$B=e^{A'}\sin B'.$$

Solutions were also offered by A. R. Haynes, Tacoma, Wash. and the proposer.

2494. *Proposed by Julius Sumner Miller, El Camino, Calif.*

1. A block rests on the floor of a cart, the floor being inclined as shown. The coefficient of friction is μ. Show that the maximum acceleration which can be given to the car (toward the left) without causing the block to slid UP is

$$a=g\,\frac{\mu+\tan\theta}{1-\mu\tan\theta}$$



Solution by the proposer

Let the horizontal acceleration be a.
Then, the component of a up the plane is $a\cos\theta$.
This is diminished by the component of gravity $g\sin\theta$.
The normal component of a gives the frictional force $\mu a\sin\theta$.
This is enhanced by the frictional force due to gravity, $\mu g\cos\theta$.
Hence,

$$a\cos\theta-g\sin\theta=\mu g\cos\theta+\mu a\sin\theta.$$

From which a is at once,

$$g\,\frac{\mu+\tan\theta}{1-\mu\tan\theta}\,.$$

Solutions were also offered by Millard Agerton, Preston, Ga. and Alan Wayne, Brooklyn, N. Y.

2495. *Proposed by J. W. Lindsey, Amarillo, Tex.*

In terms of the sides of a given inscribed triangle find the radius of a circle.

Comment: This is the same as problem **2471** for which a solution is given on page 752 of the December 1955 issue of this JOURNAL.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each student contributor will receive a copy of the magazine in which his name appears.

The Student Honor Roll for this issue appears below.

2485. *Susie Cooper, Michael Everngam, John Osenski, Jr., Eddie Segar, Mary Todd and Jimmy Ward, all of Caroline High School, Denton, Md.*

2496. *Dan Edgar and Dale McQueen, Firelands High School, Kipton, Ohio.*

2496. *Dalton Woolverton and Lee Tipton, De La Salle High School, New Orleans, La.*

2496. *Gary Hufbauer, La Jolla, Calif.*

2496. *Charles King, Denton, Md.*

2496. *Peter Landweber, Iowa City, Iowa.*

2496. *Cora Torre, San Francisco, Calif.*

PROBLEMS FOR SOLUTION

2515. *Proposed by Paul J. Malie, Hickory, Pa.*

Mr. K. always takes the 7:30 train home. His chauffeur arrives at the station just as the train is due every day. One day, Mr. K. took the 6:25, but his secretary forgot to call the chauffeur; accordingly, Mr. K. got off the train at the station, and seeing no chauffeur, started to walk to his home at the rate of 3 miles per hour. He met his chauffeur who turned and got him home 10 minutes earlier than usual. Assuming that no time was lost in car operation, what was the speed of the car?

2516. *Proposed by Howard D. Grossman, New York, N. Y.*

If from opposite vertices A and C of parallelogram $ABCD$ lines AO and CO are drawn meeting at O and making equal angles with AB and CB respectively, then angle AOB equals angle COD.

2517. *Proposed by Dwight L. Foster, Tallahassee, Fla.*

If

$$a+\frac{bc-a^2}{a^2+b^2+c^2}$$

be not altered in value by interchanging a pair of the letters a, b, c not equal to each other, it will not be altered by interchanging any other pair, and it will vanish if $a+b+c=1$.

2518. *Proposed by A. R. Haynes, Tacoma, Wash.*

If AC and BD are diagonals of the square $ABCD$ and M is any point on its circumcircle, show that the points in which MA and MC cut BD are concyclic with the points in which MB and MD cut AC, the diagonals being produced as required.

2519. *Proposed by Hugo Brandt, Chicago, Ill.*

A cylindrical hole with radius r is drilled along a diagonal of a cube of side s. Find the volume of the material removed.

2520. *Proposed by N. Kailasamaiyer, Madras, India*

Resolve into factors

$$a(1-b^2)(1-c^2)+b(1-c^2)(1-a^2)+c(1-a^2)(1-b^2)-4abc$$

BOOKS AND PAMPHLETS RECEIVED

ALGEBRA AND ITS USE, Book 1, by Ethel L. Grove, *Formerly Cuyahoga Heights High School, Cleveland, Ohio;* Anne M. Mullikin, *Germantown High School, Philadelphia, Pennsylvania;* and Ewart L. Grove, *University of Alabama, University, Alabama.* Cloth. Pages vi+454. 15×23 cm. 1956. American Book Company, 55 Fifth Avenue, New York 3, N. Y. Price $3.20.

ELEMENTARY ALGEBRA, by William G. Shute, William E. Kline and William W. Shirk, *Instructors in Mathematics, The Choate School, Wallingford, Connecticut,* also Leroy M. Wilson, *Professor of Mathematics, Middle Georgia College, Cochran, Georgia.* Cloth. Pages viii+488. 14×22 cm. 1956. American Book Company, 55 Fifth Avenue, New York 3, N. Y Price $3.20.

SCIENCE FOR PROGRESS, by Maurice U. Ames, *Principal, Frank D. Whalen Junior High School, New York City,* Arthur O. Baker, *Directing Supervisor of Science, Cleveland Board of Education;* and Joseph F. Leahy, *Science Instructor, Herrick Junior High School, Cleveland, Ohio.* Cloth. 568 pages. 17×23.5 cm. 1956. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $4.40.

PLANE TRIGONOMETRY, Third Edition, by Alfred L. Nelson, *Professor of Mathematics,* and Karl W. Folley, *Professor of Mathematics, Wayne University, Detroit, Michigan.* Cloth. Pages xi+195+134. 15×23.5 cm. 1956. Harper and Brothers, 49 East 33d Street, New York 16, N. Y. Price $3.50.

ARITHMETIC FOR ENGINEERS, by Charles B. Clapman. Fifth Edition Revised and Enlarged. Cloth. Pages xiii+540. 13.5×21.5 cm. 1955. Messrs. Chapman and Hall, 37 Essex Street, London, England, W.C.2. Price 21s.

AIRCRAFT TODAY, Edited by John W. R. Taylor. Cloth. 96 pages. 18×24.5 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $4.75.

SCIENCE FOR MODERN LIVING. Books 1, 2, and 3 by Victor C. Smith, *Ramsey Junior High School, Minneapolis, Minnesota,* and Katherine Clarke, *The Meramec School, Clayton, Missouri* in Consultation with W. R. Teeters, *St. Louis, Missouri.* Cloth. Book 1, Science Along the Way, 128 pages. Book 2, Science Under the Sun, 160 pages. Book 3, Science Around the Clock, 160 pages. Books 4, 5, and 6 by Victor C. Smith, Barbara Henderson, *Kansas City Public Schools, Kansas City, Missouri* in Consultation with W. R. Teeters. Book 4, Science Across the Land, 224 pages. Book 5, Science Through the Seasons, 352 pages. Book 6, Science Beneath the Skies, 352 pages. All books 14×21 cm. 1956. J. B. Lippincott Company, 333 West Lake Street, Chicago 6, Illinois.

EXPLORING MODERN SCIENCE, Grade 7, Second Edition, by Victor C. Smith· *Ramsey Junior High School, Minneapolis, Minnesota,* and W. E. Jones, *Evanston Township High School, Evanston, Illinois,* in Consultation with W. R. Teeters, *St. Louis, Missouri.* Cloth. Pages xiv+353. 14.5×22 cm. 1956. J. B. Lippincott Company, 333 West Lake Street, Chicago 6, Ill.

ENJOYING MODERN SCIENCE, Grade 8, Second Edition, by Victor C. Smith· *Ramsey Junior High School, Minneapolis , Minnesota,* and W. E. Jones, *Evanston Township High School, Evanston, Illinois* in Consultation with W. R. Teeters, *St. Louis, Missouri.* Cloth. Pages xiv+466. 14×22 cm. 1956. J. B. Lippincott Company, 333 West Lake Street, Chicago 6, Ill.

USING MODERN SCIENCE, Grade 9, Second Edition, by Victor C. Smith, *Ramsey Junior High School, Minneapolis, Minnesota,* and W. E. Jones, *Evanston Township High School, Evanston, Illinois* in Consultation with W. R. Teeters, *St. Louis, Missouri.* Cloth. Pages xiv+654. 14×22 cm. 1956. J. B. Lippincott Company, 333 West Lake Street, Chicago 6, Ill.

BUILDING HEALTH, Second Edition, by Dorothea M. Williams, *Cole Junior High School, Denver, Colorado.* Cloth. Pages xii+431. 16×22.5 cm. 1956. J. B. Lippincott Company, 333 West Lake Street, Chicago 6, Ill.

ENJOYING HEALTH, Second Edition, by Evelyn G. Jones, *Denver Public Schools,* Cloth. Pages xii+433. 16×22.5 cm. 1956. J. B. Lippincott Company, 333 West Lake Street, Chicago 6, Ill.

PHILOSOPHICAL WRITINGS OF PEIRCE, Edited by Justus Buchler, *Associate Professor of Philosophy at Columbia University*. Paper. Pages xvi+386. 12.5×20.5 cm. 1955. Dover Publications, Inc., 920 Broadway, New York 10, N. Y. Price $1.95. Cloth $4.50.

KINETIC THEORY OF LIQUIDS, by J. Frenkel. Paper. Pages xi+488. 12.5×20.5 cm. 1955. Dover Publications, Inc., 820 Broadway, New York 10, N. Y. Price $1.95. Cloth $3.95.

SEMIMICRO LABORATORY EXERCISES IN HIGH SCHOOL CHEMISTRY, Second Edition, by Fred T. Weisbruch, *Principal, Don Bosco High School, Milwaukee, Wisconsin*. Paper. Pages viii+277. 20.5×27 cm. 1956. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $1.88.

MATH CAN BE FUN, by Louis Grant Brandes, *Encinal High School, Alameda, California*. Paper. Pages iv+200. 20×27.5 cm. 1956. Teachers Edition. J. Weston Walch, Publisher, Box 1075, Portland 1, Maine.

THE DIFFICULTY OF ONE-STEP ARITHMETICAL PROBLEMS IN RELATION TO THE TYPE OF FUNDAMENTAL NUMBER OPERATION INVOLVED, by Joan E. Bowers. Paper. 18 pages. 15×23 cm. 1955. University of Toronto, Toronto, Canada.

A CATALOGUE OF LABORATORY APPARATUS. 100 pages. 19.5×27 cm. The Ealing Corporation, Box 90 Natick, Mass.

BOOK REVIEWS

ELECTRICITY AND MAGNETISM, by Ralph P. Winch, *Barclay Germain Professor of Natural Philosophy, Williams College, Williamstown, Mass.* Cloth. Pages xii+755. 15×23 cm. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N.Y. Price $7.75.

This text is for the use of sophomore and junior students who have completed the general physics course and the regular junior college courses in differential and integral calculus. Some vector analysis is introduced but it is fully explained so that a previous course in vector analysis is not expected. The MKS system of units is used throughout. A careful reading of the preface will greatly assist the teacher in arranging his course. Ample provision is made for providing students with a review of elementary physics as in problems 4–11 at the end of Chapter II. At the end of each chapter will be found a large number of well graded problems, which give the necessary review of previous work and connect with the new material. The book contains many clear diagrams which form the basis of much of the discussion of the topic under explanation. Chapter V discusses the capacitor as a circuit element and Chapter VI gives the corresponding treatment of the inductor. The author is then ready for the work of Chapter VII, giving the vector method of solving A-C circuit problems. Chapter VIII gives an excellent discussion of the use of complex numbers in the solution of sinusoidal A-C circuit problems.

This is the plan the reviewer prefers but full direction is given in the Preface for the more conventional order. All will probably follow the same order following Chapter XII. The book is well written throughout and provides sufficient material for the year's work.

G. W. W.

AN AMERICAN IN EUROPE, THE LIFE OF BENJAMIN THOMPSON, COUNT RUMFORD, by Egon Larsen. Cloth 224 pages. 13×21.5 cm. 1953. Philosophical Library, Inc., 15 East 40th Street, New York 16. N. Y. Price $4.75.

This is a biography of a man, great in science but very unpopular among his

fellow workers largely because of his haughty manners and uncompromising will. He lived in four different countries but was never a loyal citizen of any one. He was married twice but did not live long with either wife. He was not loved by his one legitimate child. Born in New England in 1753, his early life was filled with the thrilling experiences of the time. His father, who lived near Boston, died when Benjamin was eighteen months old and the farm was taken over by the father's younger brother. His mother married again soon and the boy felt cheated out of her affection. In a few years he left home and was apprenticed to a Salem merchant. By the time he was eighteen he was a country school teacher, traveling around Boston and doing some work at Harvard. At nineteen he married Sarah Walker Rolfe, a thirty-three year old widow and thus became a man of considerable wealth and soon of influence. The Governor made him a Major in a New Hampshire regiment even though he had had no military experience. Soon he was acting as a spy for General Gage and left with Gage when he was driven from Boston.

All the rest of Thompson's life was spent in Europe except a brief trip to America near the end of the war, when he engaged in raids on villages and the country in Carolina. The rest of his life was spent in England, Bavaria, and France. In all these countries he engaged in relieving the conditions of the poor, in scientific experiments, and in numerous governmental and executive offices. He became a Fellow of the Royal Society in 1779. In 1784 he was in Bavaria and soon became the War Minister of that foreign country. He stationed garrisons near home, established home industries for them, introduced crop rotation on the farms, reconstructed the Mannheim workshops, and set the beggars to work. He built Munich's Hyde Park into an English garden.

Later, during the English wars with Napoleon, he went to France, met and visited with Napoleon. Later he became acquainted with Anne Lavoisier, the widow of the great chemist who had been executed. Soon they were married and he became a resident of Paris. But she was a society lady, he was a scientist and experimenter. The marriage did not last long. Rumford moved to another house and obtained a divorce in 1809. Here he lived until August 21, 1914, when death came at the age of sixty-one. You will be interested in this little book about one of the world's greatest scientists.

G. W. W.

ELECTRO-MAGNETIC MACHINES, by R. Langlois-Berthelot, M.I.E.E., M.A.I.-E.E., *Chief Research Engineer for Production and Transformation Equipment at l'Electricite de France, and Professor of Electrical Engineering at Ecole Superieure d'Electricite, Paris.* Cloth, 535 pages. 13×21.5 cm. 1955. Philosophical Library, Inc., 15 E. 40th Street, New York 16, N. Y. Price $15.00.

This book is a translation of a text published some years ago in France. It was later translated and revised in collaboration with Lieut.-Colonel H. M. Clarke of King's College, University of London and now appears in English with a Foreword by C. W. Marshall. After a study of Part One, which discusses the various families of electrical machines, the American reader may well make some study of the Appendix, which gives an explanation of the symbols used in treating sinusoidal functions with complex quantities, properties of systems of impedances, polyphase systems, etc. He will then be able to proceed without constant reference to the appendix. Part Two deals with the general structure and use of electrical machinery. Here are ten important chapters which should give the student the ability to carry out the calculations, making use of the appropriate symbols and the necessary mathematical processes. Part Three, Chapters X–XIX, discusses the machines from the designer's viewpoint: the properties of the materials used, insulating materials, effects of temperature changes, losses, dialectric stress, distribution of voltage, and commutation. Part Four, Chapters XX–XXV, discusses the machine from the point of view of the user. Part Five, Chapters XXVI–XXVIII, is on abnormal conditions of operation: harmonics, unbalanced conditions, and transient conditions for the

fluxes and currents. Part Six gives miscellaneous general comments in regard to flux, reactive power, industrial research, etc.

This a book which all English speaking students may well consider. It is filled with excellent diagrams and complete discussions. The translation is clear, so that at no point will the student feel that he is at a loss because he does not read French. It should be in all college libraries even if it may not be adopted for class use.

G. W. W.

TREASURY OF PHILOSOPHY, Edited by Dagobert D. Runes. Cloth. Pages xxiv +1280. 14×21 cm. 1955. The Philosophical Library, Inc., 15 East 40th Street, New York 17, N. Y. Price $15.00.

This is a truly comprehensive collection of the philosophical writings of the world. It goes back in history to the time of Thales in the Sixth century B.C., picking out the important thinkers of all countries, and continuing to the present time, several of whom are still living. It is one of the first books in its field to recognize the contributions of the American continent. Possibly the life of the author may be largely responsible for this. Born and educated in Europe, he received his Doctor of Philosophy degree from the University of Vienna but later came to this country and now seems well pleased with life in the United States.

The authors are listed alphabetically, thus making reference easy. Each entry gives the important events in the philosopher's life, lists his major contributions, and gives a judgment of his place and importance in the field. This is followed by one or more excerpts from his productions. The number of pages or paragraphs given here is an indication of the author's opinion of the philosopher. No doubt many of those mentioned are entirely unknown to most of our readers since some of the material given is here in English translation for the first time. Among these will be found names of Chinese, Arabian, and Indian writers, as well as possibly even some from the Mediterranean countries.

A list of a few of the American thinkers will show how well the field has been covered. Here we find John Adams, Amos Bronson Alcott, Ethan Allen, Henry Ward Beecher, Louis Brandeis. P. W. Bridgman, Ralph Waldo Emerson, Benjamin Franklin, Abraham Lincoln, Oliver Wendell Holmes, both Sr. and Jr., and Woodrow Wilson. These are placed here with such great thinkers of all countries, such as Confucius, Aristotle, Francis Bacon, and Roger Bacon, Einstein, Locke, Plato, and Voltaire. You may not agree throughout, some have been included that you would omit, others that you think great have been left out, but that is to be expected in any similar book. But it is a wonderful volume, worthy of a place in any library.

G. W. W.

DISTANCE AND AZIMUTH COMPUTATIONS, with Tables.

This is a book prepared by Harry C. Carver, Professor of Mathematics at the University of Michigan, for the Air Research and Development Command. It bears the date, September, 1954. Its general nature may be told by quoting the Preface, which reads as follows:

> "This text on Distance and Azimuth Computations is a first step in presenting under a single cover the basic mathematics that are related to various navigation and bombing techniques.
>
> "From time to time, this initial text should be evaluated and revised by Air Force Academy committees, in efforts to maintain an up-to-date mathematical text dealing with the theoretical side of Air Force operations. Because of the rapidly changing nature of Air weapons and operations, future revised editions of this text may well differ essentially in many respects from this initial effort."

In the introduction the author points out that the difficulties of celestial

navigation are not in the mathematics but rather in excessive demands in collecting the small number of principles involved from the literature of astronomy. This book is an attempt to do this job and to explain its use to the navigator so that this work may be done accurately and rapidly. The book consists of only eight chapters but many of these are divided into a number of separate topics with complete discussion and solution of problems presented. These chapters cover 217 pages, 21×28 cm., and are followed by an Appendix of 151 pages of important tables.

To one not acquainted with this field the book seems to be a completed masterpiece, but the author is no doubt correct in saying that future revisions may greatly change the text. The book is not yeat ready for general distribution, hence no price is given.

G. W. W.

INTRODUCTION TO COLLEGE PHYSICS, by Frank M. Durbin. *Professor of Physics· Oklahoma Agricultural and Mechanical College.* Cloth. Pages xiv+780. 15×23 cm. 1955 Prentice-Hall, Inc. 70 Fifth Avenue, New York 11, N. Y.

"Prepared: for college students; approached: from the liberal arts viewpoint." That is the preface promise. The implication, in that preface, seems to be that when "certain topics may be studied . . . without the aid of trigonometry" that viewpoint has been achieved. Further, before the student has read through the second page he is told that, "Looking for 'practical applications' and wondering 'What good this will do me?' will detract from the value of the study."

The offering, in general, is that of the usual introductory courses of this subject. The presentation tries to provide a "break in" by delaying accelerated motion until seven chapters on measurements, vectors, equilibrium, energy, machines, fluid statics and elasticity have been considered.

Physics of "Small Particles" is featured by giving it about thirty per cent of the book's pages. A publisher's "blurb" forecasts user enthusiasm over the author's style as he presents that, as "modern" physics. In that, last section, the electron, atom structure, radioactivity, nuclear reactions and phenomena are quite generously and interestingly explained. (Transistor and the "atomic" battery are not there.)

Pattern followed uses clear, terse exposition with frequent appeal to supporting diagrams. It rarely enlists what may be considered demonstration support. All illustrations are line drawings, most of them diagrammatic. A rather routine chapter format is followed: First, an introduction, then orderly treatment of sub-topics, concluded by a summary, sample problems and lastly problems of application.

It is gratifying to find that some "practical applications" did slip into both the text matter and the problems. A gesture toward the historic aspects is found in a seven and one half page roster of "Names mentioned in the text."

For a "liberal arts point of view," this reviewer considers it regrettable that the historic part of the science was so generally ignored. In that connection, is not the sort of thinking, the old masters did in arriving at the results we so glibly catalogue in our books, of more than passing concern? The author also seems to have implicit faith in problem-solving as a means of getting understanding. Some of us have found many Faradays, who were unskilled in the language of mathematics, in our physics classes, even though there may have been an occasional potential Maxwell there also.

Even so, Dr. Durbin has, in this volume, made a creditable creative contribution to the list of learning resources for students of beginning college physics. Teachers of that subject should also find it valuable for their own use as they plan and administer their courses.

B. CLIFFORD HENDRICKS
457 24th Ave., Longview, Wash.

EXPERIMENTAL ELECTRONICS FOR THE BEGINNER, by Lewis A. Blevins and Leonard R. Crow, *Universal Scientific Company.* Part I—Electronic Compo-

nents, and Fundamental Circuitry. Paper. 360 pages. 19.5×28.0 cm. 1955. Universal Scientific Company, Inc., 1102 Shelby Street, Vincennes, Indiana. Price $3.60.

Electronic equipment requires maintainance as well as installation. A maintainance man needs knowledge of the "fundamentals of electronics." It is the ambition of the authors to initiate that training by the use of this manual.

After a "Foreword" and some attention to "Experimental Techniques followed by a five page listing of "Standard Abbreviations" comes a series of sixty "Exercises." They provide studies and measurements of: Capacitance, voltage control, inductance, frequency adjustment, resistance, instrument studies, resonance, rectification and counter electromotive force.

While each exercise is labelled an "Experiment," many are no more than running explanations for the student as he inspects the instrument or "set up" before him. When reports are required they are, prevailingly, in a tabular form. Practically every exercise is accompanied by a photograph of the apparatus and one or more wiring diagrams.

The mathematics and directions for these experiments are rated easily understandable by high school students. However, fuller mathematical treatment is included for those sufficiently interested and capable of following its development. The book is geared to an apparatus unit called the "Crow Basic Electronics Kit 50-A." In spite of the impression that this manual may have been prepared in order to sell the apparatus which authors' company manufactures the book has the qualities one looks for when he teachers such a course. As this reviewer inspected the book he sensed a growing wish to see it tried by a group of interested students. Trade school and "short course" teachers will find an examination of this book rewarding. A second volume on "Electronic Tubes, Circuits and Devices" is in preparation by the same authors.

B. CLIFFORD HENDRICKS

PRINCIPLES OF MATHEMATICS by C. B. Allendoerfer, *Professor and Executive Officer, Department of Mathematics, University of Washington* and C. O. Oakley, *Professor and Department Head, Department of Mathematics, Haverford College*. Cloth. Pages xv+448. 16×23.5 cm. McGraw Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. 1955. Price $5.00.

This text, deliberately departing from the traditional content of freshman courses, introduces material from the field of logic, the number system, groups and fields, sets, Boolean algebra, and statistics. Much of the material introduced has heretofore been thought suitable only for advanced courses; the authors seem to have done an excellent job of making the material of use on the first year level. With such a radical innovation, opinions will differ as to the suitability of the text for a particular school. The question can only be answered by detailed examination of the text, perhaps only by actual trial; comments in this review are only suggestive of further analysis by the interested teacher. The book contains ample material for a year course meeting five times a week, on the other hand by careful selection of topics, it could be used for a one semester course meeting thrice weekly. The authors have suggested the number of lessons which should be devoted to the various chapters; in the reviewer's opinion these are minimum, and for better than average students. Although the authors state it is possible to teach certain material to students without Intermediate Algebra, it is doubtful if this is advisable.

Certain features seem especially praiseworthy; in addition to the general plan of the book, which certainly has great merit, one might mention as other items: the inclusion of problems in mathematical induction where one or both of the conditions are not satisfied; the excellent treatment of the definition of a function (restricted to a single-valued function, the multiple-valued function is defined as a "relation"), including discussion of the domain and range; a refreshing approach to the subject of trigonometric functions; the use of direction cosines for

the line in a plane; specifically stating that the parametric equations of a curve may not represent the same curve as the cartesian equations; the introduction of integration as a topic in the calculus before considering differentiation (in fact, both concepts are introduced independently first, then the inverse relationship pointed out).

Obviously all features are not pleasing to everyone. There are some points, perhaps minor in nature, which the reviewer noted, to which some might object. In Section 12, the introduction of coordinates of a point as an ordered pair implies a rectangular system, although this is not explicitly stated; later references however refer to a rectangular system. On page 273 in discussing the connection between rectangular and polar coordinates it is stated that "By superposition of the two systems we find . . ." without any qualification as to how the superposition is to take place. The definition of the value of the median (or quartiles or percentiles) does not agree with that used in many statistics texts, yet the existence of alternative definitions is not pointed out. Some will not agree that the geometric mean is rarely used for statistical purposes. Some instructors may feel that the treatment of exponents and radicals is too brief (two and one half pages); others will object to the fact that there is no material in analytic geometry specifically devoted to curve tracing (as for example, the treatment of symmetry); still others may feel that three pages is not sufficient for the treatment of trigonometric identities. With the concept of function restricted to what is often called a single valued function, the treatment of the inverse trigonometric functions differs somewhat from the traditional—the notation is arc Sin x rather than Arc sin x; no mention is made of the inverse secant and cosecant. In using the index to find a topic noticed earlier the reviewer found that the reference to the distance between two points is apparently a section rather than a page reference. Problems are in general ample in number, in a few places additional exercises would have been helpful in order to provide alternate selections in various semesters. More difficult exercises are indicated; answers are given to some, but not all, of the examples. Tables are not included, it is assumed the student will have use of one of the standard tables available.

For the teacher wishing a course which contains more of modern mathematics, this book offers great possibilities; the teacher who is undecided should by all means examine the book in order to see what can be done on the freshman level. Even if not adopted as a text, the book could well be placed in a library as a source of material, readable by the student, on topics which he may wish to investigate. By no means the least valuable of the features of the book is the set of references at the ends of chapters, including not only books, but selected articles from the American Mathematical Monthly.

Cecil B. Read
University of Wichita

The Hidden Life of Flowers. A translation from a French text by J. M. Guilcher with photographs by R. H. Noailles. Cloth. Pages 93. 1954 Philosophical Library, Inc., 15 East 40th St., New York 16, New York Price $4.75.

A collection of photographs depicting the various phases in the reproduction of plants. The book is attractive with large clear pictures and a minimum of reading material.

The brilliant photography makes each page a study in itself. The unique story of reproduction is graphically presented. Few of us have ever been aware of the astonishing stages of reproduction as shown in this book.

Most of us are not familiar with the Corn Poppy in this country, but a study of this plant can help us to appreciate the beauty and marvelous changes that occur in the reproductive process as is shown by photography. Each picture shows the manification used, thus helping the reader to get some idea as to relationship as to size.

A very useful book in advanced botanical studies. A copy would be good to

have to refer to whenever there is a detailed study of plant reproduction and the reproductive process.

NELSON L. LOWRY
Arlington Heights, Ill.

THE FERNS AND FERN ALLIES OF MINNESOTA, by Rolla M. Tryon, Jr. with Illustrations by Wilma Monserud. Paper. Pages xx+166. 1954. University of Minnesota Press, Minneapolis, Minnesota. $2.75.

A study of the ferns and allies of the state of Minnesota with Maps showing areas where each has been identified within the state. These distribution maps have been prepared from collection of ferns in the herbarium of the Department of Botany of the University of Minnesota.

The use of the key to families is to identify ferns that are found in the state. This should be useful in identification of these same families found in other sections of the country.

The section on Fern Allies seems to be complete. The key to species is easy to follow for identification of species.

Illustrations of allies of ferns are good to give the student unfamiliar in using a key picture of what he is looking for.

This book should be of use to other sections of the country with some of the same climatic and terrain conditions as are those found in the state of Minnesota. The amateur as well as the professional Botanist can find this book useful and interesting in the study of ferns and their allies or in the identification of an occasional species.

NELSON L. LOWRY

NEW SOLID GEOMETRY, by A. M. Welchons and W. R. Krickenberger. Cloth. Pages x+326. 14.5 cm. ×21 cm. 1955. Ginn and Company, New York. Price $2.68.

The authors of this text have established themselves as successful authors of high school mathematics texts. This text is no exception. It is a slight revision of the authors' previous texts in this field. For anyone wanting a text with the straightforward approach from the definition to the demonstration this one will meet his needs.

There are some features which have been expanded beyond the treatment given in previous editions. Perspective drawing is discussed and several good exercises provided. The work with spherical distances has been expanded as one of the supplementary topics. The book contains an abundance of exercises but many of them are too simple to challenge bright students. The subject of locus seems to be treated more extensively than is probably justified in a solid geometry course.

As I see it, there are only two areas where this book does not meet the high standards these authors have always set for themselves. The first is the use of measurement as it is related to precision and approximate computation. There are many problems of a numerical nature in the text and it would seem this topic should be covered. The second area of weakness is in the development of an appreciation for the structure of geometry. The authors have in some instances tied together the basic principles of the field, but it would appear this might be emphasized to a greater degree. For example, at the close of each chapter is found, "Summary of Principal Methods of Proof" in which are listed all facts. The student must make his own connections and I am afraid this is not often done.

The text contains all the material needed from Plane Geometry, it is well indexed, has sufficient tables with the drawings and pictures a functional part of the text.

I have used the previous editions of this book and want to congratulate the authors on the carefulness and correctness of their publications. The errors are

always negligible. Anyone wanting a standard Solid Geometry text should certainly consider this one.

PHILIP PEAK
Indiana University,
Bloomington, Indiana

ALGEBRA ONE, by Rolland R. Smith, *Coordinator of Mathematics, Springfield, Massachusetts, Public Schools;* and Francis G. Lankford, Jr., *Professor of Education, University of Virginia.* Cloth. pages vi+410. 14.9×22.7 cm. 1955. World Book Company, Yonkers-on-Hudson, New York. $2.80.

The first feature one notices in this text is the use of color and colored type to emphasize principles and aid in explanation. The location of the red print was generally well done, but in a few places it appears unnecessary. For example, in giving dimensions of geometric figures and in labelling the several similar parts of one problem the color attracts attention while other equally important ideas suffer by comparison. Algebra One closely follows the traditional organization: equations, signed numbers, graphing, simultaneous equations, factoring, roots and radicals and quadratics. It also contains chapters on ratio, proportion, and variation, and numerical trigonometry. I was impressed most by the completeness of coverage of the subject and the attention to detail. This includes anticipating the student's questions and pointing out errors often made in reducing fractions. The authors introduce all appropriate terms and also some which are often omitted, such as the associative law, and use them throughout the book so that the student will add them to his vocabulary. Some students would find the book hard to read; especially some of the definitions and rules.

Examples are presented before the rules so that the student may inductively discover them. Many "Before You Begin" exercises review previously studied material before it is used in a new area. Verbal problems are introduced early and there are many lists with a variety of types of problems spaced through out the book. Ample practice and review of the principles of arithmetic are provided. Chapter and cumulative reviews follow each chapter, but chapter tests are not included. Puzzle problems, magic squares, and historical information and problems aid in motivation "Extra" lists of problems provide for the interested and more capable student. I was favorably impressed with this book. Anyone considering adopting a new text in algebra would profit from examining this one.

CHARLES R. STEGMEIR
Lyons Township High School
La Grange, Illinois

PLANE GEOMETRY, by Arthur F. Leary, *Head of Mathematics Department, Hyde Park High School, Boston, Mass.*, and Carl N. Shuster, Ph.D., *Head of Mathematics Department, New Jersey State Teachers College at Trenton.* Cloth. Pages ix+510. 15×23 cm. 1955. Charles Scribner's Sons. Price $3.80.

This text differs somewhat from the conventional plane geometry text. This is due in part to the numerous objectives the authors envision for the plane geometry course. They state that improvement in deductive reasoning ability is certainly one objective; but equally important objectives are the ability to recognize the basic forms, knowledge of the terms used in describing them, familiarity with the formulas involving them, improvement in reasoning inductively, improvement in the general ability of analysis, and the development of imagination and the power of observation. The text is designed to meet these objectives.

The order of topics is not unuaual although two traditional topics are given very scant treatment. Indirect reasoning is discussed in one short section in the last chapter of the book which is entitled, "The Road to Better Reasoning." Locus is relegated to the next to last chapter entitled, "Locus Problems and Review Questions." The treatment of locus is largely descriptive.

The treatment of the material is somewhat unusual. There are no separate listings of axioms and postulates. Both are simply called assumptions and are

introduced when necessary. None of the five basic congruence theorems are proved, all are stated as assumptions. Vertical angles are "proved" to be equal before the axiom necessary for proof has been stated. The treatment of parallel lines is, of course, unusual because indirect proof is not used.

There is a chapter on arithmetic and algebra with geometric applications. There is also included a chapter on trigonometry and graphs in which the elements of analytic geometry are introduced. Rules for computation with approximate numbers are given in the chapter on arithmetic and the rules are followed in other computations throughout the book. A whole chapter is devoted to the Pythagorean theorem and its applications.

Always of primary interest to mathematics teachers are the exercises and other supplemental material contained in the text. The exercise material in this book seems entirely adequate in both quantity and variety. There is always a review section at the end of each chapter. The text was written so as to be readable by high school students. Good use is made of color, important statements and parts of figures that need emphasis being printed in red. An appendix contains all the important formulas and relations, including some from solid geometry and a very good table of trigonometric functions.

William Stretton
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Using Mathematics, by Kenneth Henderson, *Professor of Mathematics, University of Illinois*, and Robert E. Pingry, *Associate Professor of Mathematics and Education, University of Illinois.* Cloth. Pages xvi+555. 14.5×22 cm. McGraw-Hill Book Company, Inc., New York, N. Y. 1955. Price $3.36.

Using Mathematics is a General Mathematics text written with two different kinds of students in mind. Material has been included to aid the student whose interest and proficiency have improved to the point when he may want to continue his mathematics training. The student who will terminate his mathematics training with this course has also been given ample consideration.

Chapter one, "Using Drawings in Mathematics," is an approach different from most texts in the field. The authors feel that the opportunity to succeed, with relatively easy material and material that is likely to be new, will stimulate a favorable attitude toward the course, and provide a psychological advantage for the student.

Each chapter begins with an explanation of why the content is important for the student. A brief summary of goals to be attained by the student is listed. Pre-tests are found throughout the chapters, designed to help the student determine his degree of competence. Explanations and drill work are written in a way that develops understanding. Drawings and cartoons are used in many places to illustrate verbal explanations. The authors have included exercises that will challenge students of different levels of competence. There is an abundance of exercises selected from a wide variety of interests. Important skills, concepts, and vocabulary are summarized at the end of each chapter followed by two self-tests. The first of these is a test to determine if the goals of the chapter were attained. The second is a review of material found in previous chapters. A portion of the review stresses some work "without paper and pencil."

A list of the chapter headings will give an idea of material covered in the text.

1. Using drawings in mathematics.
2. Measuring—common fractions.
3. Measuring—decimal fractions.
4. Comparing numbers—ratio and percent.
5. Studying facts—graphs.
6. Formulas.
7. Figuring your earnings.
8. Managing your money.
9. Using credit wisely.

10. Saving and investing your money.
11. Solving problems—equations.
12. Making use of signed numbers.
13. Measuring indirectly.

I feel that *Using Mathematics* does meet the needs of the two kinds of students previously mentioned in paragraph one. The book contains an abundance of material, probably too much to be covered by the average General Mathematics class in a one year course. Anyone using the text would have to plan and select material that would best meet the needs of his class. The book does challenge the more competent student, and also offers the less gifted ample work.

Using Mathematics is an excellent General Mathematics text and should be given careful consideration if your school is in the process of adopting a new text in this field.

RICHARD ELLIS
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La Grange, Illinois

NEW MAP OF CANADA

A big, new, relief map of Canada for offices, homes and schools was published by Aero Service Corporation, Philadelphia, worldwide aerial mapping company. It shows Canada in a realistic third dimension, as it might be seen from the air.

Forty-nine by 45 inches in size, the map is printed in 8 vivid, naturalistic colors on heavy Vinylite. Then the plastic is vacuum formed to show mountains, valleys and drainage patterns in clear relief. Mt. Logan, for example, rises nearly an inch from the lowest point of the map.

The land-use colors are vivid: an icy blue for snow covered areas, lavender for tundra, a tan earth color for cultivated lands. Grazing lands, forests and other land-use information is shown for all Canada. These colors are protected by plastic coating the map surface; thanks to the coated surface, the map may be marked with soap crayons or china marking pencils without damage. Markings, fingerprints and dust wipe off the coated surface easily.

Scale of the Canada map is 1 inch equals 75 miles, or a ratio of 1:4,752,000. The map extends from the Chicago area to north of Cape Columbia, near the 84th parallel, showing fully the Canadian Arctic which is becoming so important strategically and economically. The map's vertical exaggeration (common to all relief models, to emphasize land forms) is 20 to 1.

This new map weighs only 2 pounds. A conventional relief model, made of plaster, would weigh over 200 pounds in the same size.

Three maps are combined in one in this relief map, which shows

1) land forms
2) land use
3) over 3,000 geographical names

Typical of the map's up-to-date information is its depiction of recently verified shoreline locations in the Canadian Arctic. Older maps show Prince Patrick Island, for example, 80 miles out of position. Banks Island's position was in error by 20 miles. Thanks to new and authoritative data from the Canadian Government, these island positions are correct on this map. New communities in the Arctic are also correctly shown, along with the newly named Queen Elizabeth Islands.

The relief map of Canada shows 3,000 place names, including 1,500 cities and towns. Nearly 1,000 lakes and streams are named, plus about 500 capes, points, islands and peninsulas. Mountain ranges and peaks are listed, along with 300 "spot elevations" citing mountain heights and other terrain elevations in Canada. Highest point on the map is 19,850 ft.: Mt. Logan in the Yukon Territory.

Price of the Canada map is $45.00, f.o.b. Philadelphia. If more information is wanted, please write or phone Robert Sohngen, Aero Service Corp., Philadelphia 20—Michigan 4-8500.

A SCHOOL FOR ADVANCED STUDY

Establishment of a School for Advanced Study at Massachusetts Institute of Technology has been announced by President James R. Killian, Jr.

The new school will provide means by which post-doctoral scholars from all over the world can join with the M.I.T. faculty in high-level theoretical studies and research. Dr. Martin J. Buerger, professor of mineralogy and crystallography, has been appointed director.

The announcement was made at a dinner at The Waldorf-Astoria given by the M.I.T. Corporation for 1,500 guests, including many alumni. Tribute was paid to the late Karl T. Compton, former president of the Institute, by Dr. Killian and the other speakers, Robert Cutler, Boston, consultant to the National Security Council, and Robert E. Wilson, Chicago, chairman of the Standard Oil Company of Indiana. Mr. Wilson, a member of the M.I.T. Corporation and for 54 years a close friend of Dr. Compton, told how his leadership brought the Institute into pre-eminence in science as well as engineering.

The new school will formalize opportunities for advanced study which are already available at M.I.T., Dr. Killian said.

"The advance in knowledge makes it increasingly important for scholars to pursue advanced study beyond the level of the graduate school and the doctor's degree," Dr. Killian pointed out. "In fact, the advancement of American science particularly requires more post-doctoral study and research in our educational institutions.

"In its initial embodiment the school will be simply an organizational entity, but we hope ultimately to provide a center and adequate housing for fellows and guests and by this means to gain the advantage of cross stimulation of ideas which occurs when learned and ingenious men are brought together into close social contact."

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40 TEEN-AGE FINALISTS NAMED AS ANNUAL SCIENCE TALENT SEARCH SETS NEW RECORD

Forty teen-agers were named finalists in the fifteenth annual Science Talent Search as judges completed the difficult task of sifting winners from a field that began with 20,828 aspirants, highest in the history of this nation-wide scholarship competition.

Chosen as the nation's most prominent future scientists, the eight girls and 32 boys were awarded all-expense trips to Washington. In the fifteenth Search, New York continued to lead all states in the number of winners produced—five boys and two girls. Five of the seven come from New York city and vicinity. California won second place with four finalists, all boys, one of whom attends school in Exeter, N.H. Illinois, Indiana and Minnesota tied for third place with three winners each.

Four states will send two winners each—Arizona, New Jersey, Virginia and Wisconsin. Eleven home states and the District of Columbia are represented by one winner each. The states are Georgia, Iowa, Maine, Maryland, Massachusetts, Michigan, Montana, Oklahoma, Oregon, Pennsylvania and Washington.

Begun in 1942, the Science Talent Search is conducted by Science Clubs of America through Science Service. Awards are made by the Westinghouse Educational Foundation, which is supported by the Westinghouse Electric Corporation.

"These 40 young scientists will help us win the continual race against both stagnation of our civilization and the danger of domination by the communist world," said Watson Davis, director of Science Service. "We can predict that their scientific contributions in the future will help conquer some of the world's still unsolved major problems.

Preparation of Manuscripts for Publication in School Science and Mathematics

MANY articles come to our editorial office before they have been put in condition for our use and hence must be rejected. The spelling, punctuation, sentence structure, and all mechanics of the manuscript should be correct before it is submitted. Do not count on making such corrections when you receive the galley proof. All changes in proof mean extra expense. This journal is not endowed and all expenses must be paid out of receipts from subscriptions and advertising. It is a cooperative enterprise. Make your original manuscript exactly right and perfectly clear.

Papers for publication should be sent to **Glen W. Warner, Editor, Lakeville, Indiana.** Return postage should be included if the manuscript is to be returned if rejected.

Manuscripts submitted should not have been published elsewhere. They should be original typewritten copies, double or triple-spaced with wide margins on 8½" x 11" paper.

References and footnotes should be numbered consecutively throughout the article and indicated by superior numbers. The reference or footnote should be set off by rules and placed immediately below the citation.

Bibliography should be given thus:
FRANKLIN, G. T. "Analysis in First Year Chemistry," *Journal of Chemical Education,* 7, pp. 361-364, February, 1930.

Drawings should be made on good quality white paper in black India ink. Letters, numbers, etc., which cannot be set in type at the margin of the cut must constitute a part of the drawing. They should be proportioned to insure legibility in the cut. Illustrations to appear as full page productions should be proportioned suitable for a 4" x 7" page.

Tabular Material should be proportioned to suit page width. All tables should be double ruled at the top just below table number and heading; use single rulings for columns, sub-divisions and bottom. References to illustrations and tables should be by number, as "see Fig. 3," and not to position, as "the following table." It may not be possible to set the drawing or table at a specific position with respect to the discussion.

Reprints are supplied only when ordered and at approximate prices quoted on Reprint Order Card which will be sent you with galley proof. Orders for less than one hundred reprints cannot be accepted.

Read galley proof as soon as received, indicate corrections clearly in pencil and return to the Editor immediately.